JOINT INSTITUTE FOR NUCLEAR RESEARCH

2024

ANNUAL REPORT

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Joint Institute for Nuclear Research

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Online version: http://wwwinfo.jinr.ru/publish/Reports/Reports_index.html

ISBN 978-5-9530-0640-8

JINR MEMBER STATES

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Republic of Armenia

Republic of Azerbaijan

Republic of Belarus

Republic of Bulgaria

Republic of Cuba

Arab Republic of Egypt

Georgia

Republic of Kazakhstan

Democratic People's Republic of Korea

Republic of Moldova

Mongolia

Romania

Russian Federation

Slovak Republic

Republic of Uzbekistan

Socialist Republic of Vietnam

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Hungary

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Republic of Serbia

Republic of South Africa

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PAC for Nuclear Physics

Chairperson: V. Nesvizhevsky
Scientific Secretary: N. Skobelev

PAC for Condensed Matter Physics

Chairperson: D. L. Nagy (Hungary)
Scientific Secretary: O. Belov

INTERNAL ORGANIZATION OF THE JOINT INSTITUTE FOR NUCLEAR RESEARCH

Bogoliubov Laboratory of Theoretical Physics

Director D. Kazakov

Research in

- interactions and symmetry properties of elementary particles, field theory structure and its applications
- properties of exotic nuclei and nuclear systems, low-energy and relativistic nuclear dynamics, nuclear astrophysics
- mathematical models of complex systems, complex materials and nanostructures
- integrable systems, supersymmetry, quantum gravity and string theory

Veksler and Baldin Laboratory of High Energy Physics

Acting Director A. Butenko

Research in

- interactions of multicharged ions in a wide energy range
- relativistic nuclear physics
- structure of nucleons
- strong interactions of particles
- resonance phenomena in particle interactions
- electromagnetic interactions
- particle acceleration techniques
- applied science at NICA complex based on the ARIADNA infrastructure

Dzhelepov Laboratory of Nuclear Problems

Director E. Yakushev

Research in

- neutrino physics and rare phenomena
- strong, weak and electromagnetic interactions of particles
- nuclear spectroscopy
- charged particle acceleration techniques
- applied research and radiobiology

Flerov Laboratory of Nuclear Reactions

Director S. Sidorchuk

Research in

- synthesis of superheavy elements
- properties of heavy and superheavy elements, mechanisms of nuclear reactions with heavy ions
- reactions with radioactive-ion beams, structures of nuclei at the borders of nucleon stability
- interactions of heavy ions with condensed matter
- heavy-ion acceleration methods

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Vice-Director **L. Kostov**
Chief Scientific Secretary **S. Nedelko**
Chief Engineer **B. Gikal**

Frank Laboratory of Neutron Physics

Director E. Lychagin

Research in
- neutron-induced nuclear reactions
- fundamental properties of the neutron
- structure and dynamics of functional materials
- nanomaterials for energy storage
- materials by neutron scattering, neutron activation analysis, neutron radiography and complementary methods
- dynamic characteristics of the IBR-2 pulsed reactor and advanced neutron source

Meshcheryakov Laboratory of Information Technologies

Director S. Shmatov

Research in
- provision of operation and development of the JINR network, information and computing infrastructure
- optimal usage of international computer networks and information systems
- integration of the heterogeneous computing resources
- modern methods of computer physics, development of standard software
- digitalization of scientific and administrative activities of JINR

Laboratory of Radiation Biology

Director A. Bugay

Research in
- molecular radiobiology
- radiation genetics and cytogenetics
- medical radiobiology
- radiation physiology and neuroradiobiology
- radiation biophysics and mathematical modeling
- astrobiology

University Centre

Director D. Kamanin

Main activities:
- academic programme for senior students, preparation of Bachelor, Master, and PhD theses
- running of international student practices and schools
- popularization of achievements in modern science
- running of scientific schools for physics teachers
- career guidance for schoolchildren
- advanced training of the Institute personnel

Central Services

- central scientific and information departments
- administrative and economic units
- manufacturing units

INTRODUCTION

The year 2024 was marked at JINR with bright scientific results, important achievements in the development of the research infrastructure of the Institute, and significant events in the life of JINR as an international intergovernmental organization.

First and foremost, it is necessary to emphasize the high level of attention expressed to JINR by the state of the Institute location, the Russian Federation, to the establishment of favourable conditions for work at JINR, especially to implementation of the largest international project NICA for studies of the properties of hadron matter in extreme conditions. This is evidenced by the visit of the President of the Russian Federation Vladimir Putin to JINR in June 2024 and his strategic support of the Institute activities in the development of international scientific and technical cooperation. The President met with scientists from Russia and other JINR Member States and gave a start to the technological launching of the NICA complex. A meeting of the Presidential Council for Science and Education was held at the JINR International Conference Hall.

In 2024, preparations for combined technological testing of the main assemblies of the NICA accelerator complex were completed. An important stage of the implementation of the NICA–MPD project was executed — the superconducting magnet of the MPD detector was cooled down to liquid helium temperatures. Five runs at the NICA channels were successfully completed for applied research within the ARIADNA collaboration.

At the Flerov Laboratory of Nuclear Reactions, an experimental programme of the Superheavy Element Factory in irradiation of ^{242}Pu and ^{238}U targets with ^{50}Ti and ^{54}Cr beams, respectively, was successfully implemented. Six new events on the synthesis of livermorium were obtained. Three new isotopes were discovered: $^{288,\ 289}$Lv and ^{280}Cn. The important results bring FLNR scientists closer to carrying out the experiments on the synthesis of elements 119 and 120.

In 2024, the upgrade of the U-400M cyclotron was completed, and the facility was launched. In the first experiments, dineutron correlations in the ^{4}He(^{8}He,^{8}He)^{4}He reaction were studied at 25–35 *A* MeV.

The construction of the new experimental building for U-400R was conducted ahead of terms. In the hall of the DC-140 accelerator complex, building and assembly works were in full swing.

Scientists of the Bogoliubov Laboratory of Theoretical Physics demonstrated traditionally high publication activity and obtained significant results in theoretical and mathematical physics, nuclear physics, elementary particle physics and relativistic heavy ion physics, materials science and solid matter physics, including those aimed at JINR experimental programme. In November, an important cooperation agreement was signed in China between the Institute of Theoretical Physics of the Chinese Academy of Sciences (ITP CAS) and JINR. Under the agreement, regular exchange of visits for scientists, postgraduates and students will be carried out, and joint research of ITP CAS and BLTP, as well as other JINR laboratories, will be enhanced.

Technological work to launch IBR-2M came to the stage of completion at the Frank Laboratory of Neutron Physics. The launching of the reactor is scheduled for the first part of 2025. New detectors were installed in the FDHR and DN-6 diffractometers.

A prototype of a new facility using inelastic neutron scattering, the BJN spectrometer, was prepared for testing.

As part of applied research, FLNP scientists actively studied cathode materials for perspective sodium-ion accumulators. The staff members of the Sector of Neutron Activation Analysis and Applied Research were awarded medals at the international invention Euroinvent-2024 exhibition for elaborations in life sciences.

The Dzhelepov Laboratory of Nuclear Problems, which celebrated its 75th anniversary in 2024, successfully conducted expeditions to develop the Baikal-GVD neutrino telescope, bringing it to record levels in a number of characteristics. At present, 13 clusters consisting of more than 4000 optical modules are installed on Lake Baikal. An important scientific result was achieved in proving high sensitivity of Baikal-GVD, which was four times higher than that of the IceCube neutrino observatory (Antarctica). In 2024, the Baikal telescope discovered astrophysical neutrinos with energy higher than 200 TeV.

It is necessary to mention the active participation of JINR staff members in the DANSS and DANSS2 experiments at the Kalinin NPP, in the SPD collaboration at the NICA accelerator complex, and in upgrading the JUNO detector (China). Active work was continued to develop the MSC-230 medical cyclotron and to prepare the Linac-200 electron accelerator for launching.

The JINR Multifunctional Information and Computing Complex (MICC) achieved a new level that allows accomplishment of the Institute responsibilities in participation in international collaborations in accordance with highest world standards. In 2024, MICC processed 40 petabytes of incoming traffic, ensuring the completion of more than 10 million tasks through Tier-1 and Tier-2 grid infrastructure, along with about 3.8 million tasks on the Govorun supercomputer.

The Laboratory of Radiation Biology played a catalytic role in forming a multidisciplinary agenda of scientific research at the Institute. JINR radiobiologists developed new binary methods of ray therapy of malignant tumours using radiosensitizers. The contribution of the LRB scientists to the development of the Geant4-DNA sofware pakage for radiobiological simulation at the cell level received international acknowledgement.

Specialists of the Institute developed the interactive Detector Cenre Web Service designed to create and visualize a single database of technological areas of JINR. The application contains information about equipment, experience of using components and materials, and competences of the Institute's laboratories. This resource will promote the development of applied research and design of unique equipment on requests from organizations of the Member States.

At the visiting session in November in Minsk (Belarus), the JINR Committee of Plenipotentiaries approved the startup competition for support of innovation projects of young specialists.

In 2024, the hundredth thesis defense took place in the framework of the JINR Dissertation Councils. During the year, 26 defenses were held: 19 candidate and 7 doctoral theses.

JINR is reliably at a high level among the most "productive" world centres in publication of its materials in leading scientific international centres on a widest range of scientific fields. In 2024, the Institute organized above 80 international scientific events, including large conferences with more than 150 participants.

In 2024, the Joint Institute organized and held 70 international scientific conferences and schools, 16 workshops and 13 meetings. Eleven large scientific forums were held with the active participation of BLTP, including the international conference "Nucleus-2024", a session of the Nuclear Physics Department of the Russian Academy of Sciences and the International Workshop on Physics of Strongly Interacting Systems in China. In the field of information technologies, the MPQIT-2024 workshop and the MMCP-2024 international conference were organized, and the autumn stage of the Scientific School on Information Technologies was successfully held, where students form Russian universities took part. LRB took an active part in the organization and work of such major events as the 23rd International Scientific School for Young Scientists on Radiobiology in Obninsk (Russia), the international conference "Current Problems in Radiation Biology" in Dubna, and the VAST–JINR Workshop on Nuclear Medicine in Hanoi (Vietnam).

Due to intensive work of the JINR University Centre, more than 600 students and postgraduates from dozens of countries took part in scientific and educational programmes of the Institute (internships, practice, scientific schools) and completed qualification papers. Similar programmes were organized for teachers as well: about 70 teachers from partner organizations visited Dubna to take part in scientific schools. In total, more than 160 students participated in the START and INTEREST programmes.

Eighteen heads of various levels and coordinators from Belarus, Russia, and Uzbekistan took part in the international internship for science and natural science education leaders (JEMS-24).

The Publishing House "Prosveshchenie" issued an educational and methodical complex for school students "Physics for Grades 7–9. Engineers of the Future", produced by a group of authors from the JINR University Centre. The textbook is included in the Federal List of Textbooks by the Order of the Ministry of Education of the Russian Federation.

In 2024, for the first time in its recent history, the Dubna Branch of MSU admitted master's students to the first year of the programme "Physics". Besides, a new master's programme "Applied Mathematics and Informatics" was successfully licensed in the Russian Ministry of Science and Higher Education. The idea of establishing this programme on the

basis of the Dubna MSU Branch was justified by the need to train highly qualified staff in mathematical simulation and data processing in the megascience projects applying analytical methods for Big Data analytic and artificial intelligence.

In the international cooperation sphere, one of the most important things achieved in 2024 was signing of an agreement between JINR and the Ministry of Science and Technology of China on the start of implementation of eight joint projects and of a cooperation agreement between JINR and the National Nuclear Energy Commission of Brazil (CNEN). The ties with governmental bodies, scientific organizations and universities of Mexico, India, Serbia, and RSA grew rapidly.

Among major events was also the prolongation of the agreement on scientific cooperation with CERN, which gives hope for an early resumption of full-scale interaction between the two international intergovernmental organizations.

In 2024, the partner net of information centres of JINR widened — an Information Centre was opened in iThemba LABS (RSA), whose activities should facilitate the development of JINR–RSA international cooperation in science and education.

The social infrastructure of the Institute was actively developed. Medical service turned to the better due to radical changes in Medical Unit No. 9, which became possible thanks to the support of the Federal Medical and Biological Agency of the Russian Federation, as well as to the participation of JINR and the city administration.

In the challenging geopolitical conditions of 2024, these and many other results were achieved due to high professionalism and cohesion of scientists, engineers, workers and specialists not only in JINR laboratories, but equally in administration departments and services of the Institute.

The solution of tasks in 2025 will demand concentration of efforts in all areas of the Institute's activities. In 2025, which precedes the 70th anniversary of JINR, we must launch the NICA accelerator complex, start preparing for experiments on the synthesis of elements 119 and 120, resume the international user programme at IBR-2M, complete the large-scale reconstruction of important social infrastructure facilities, while continuing the progressive development of the Institute as a unique integration platform for multilateral international scientific and technical cooperation.

G. TRUBNIKOV
Director
Joint Institute for Nuclear Research

GOVERNING AND ADVISORY BODIES

COMMITTEE of PLENIPOTENTIARIES of the GOVERNMENTS of the MEMBER STATES of JINR

SESSION OF THE COMMITTEE OF PLENIPOTENTIARIES, 22–23 March 2024

A regular session of the Committee of Plenipotentiaries of the Governments of the JINR Member States was held on 22–23 March in Dubna under the chairmanship of the Plenipotentiary of the Government of Georgia, A. Khvedelidze.

Having heard the report presented by G. Trubnikov, JINR Director, the Committee of Plenipotentiaries took note of the information from the JINR Directorate about the recommendations of the 135th session of the JINR Scientific Council, the implementation of the current Seven-Year Plan for the Development of JINR, the efforts of the Member States towards realization of JINR's large projects, the new scientific and technological results obtained, and about the most important events related to JINR's scientific research and educational activities and international cooperation.

The Committee of Plenipotentiaries noted the high efficiency of the Institute's activities in intensifying and expanding scientific cooperation with partner organizations of JINR Member States and Associate Members, increasing the level of interaction with the People's Republic of China, the United Mexican States, the Federative Republic of Brazil, and the Republic of India.

The Committee of Plenipotentiaries appreciated with satisfaction the progress in implementing the current plan for research and development of the scientific infrastructure of JINR, the successful participation of the Institute in international collaborations, and achievements in strengthening international cooperation:

— completion of the production and cryogenic testing of components of the collider's magnetic system, readiness for commissioning the power supply system for the structural elements of the collider, preparations for the launch of a new cryogenic compressor station, beginning of the implementation of an educational programme to train operators involved in commissioning and operation of the NICA complex;

— work on reconstructing the data from the BM@N experiment, in particular, obtaining statistically significant signals of Λ and Ξ hyperons and K^0_S meson for further physics analysis;

— progress in the production of all components of the MPD first-stage detector with minimal delays;

— presentation of the updated technical design of the SPD detector (TDR) at the PAC meeting in January 2024 and the start of reviewing the TDR by the new international expert committee on detectors (Detector Advisory Committee, DAC) appointed in December 2023;

— development of the ARIADNA collaboration, whose applied research programme was launched at the NICA complex at the beginning of 2023, installation of two new stations, SIMBA and ISCRA, in addition to the SOChI station;

— successful participation of the Institute in collaborations at CERN with the fulfilment of all its obligations, as well as the high level of JINR's work under the programme for the second stage of upgrade of the ATLAS, CMS, and ALICE detectors at the LHC;

— progress in developing the Baikal-GVD deep-water neutrino telescope, installation of 576 optical modules and two bottom cable lines in 2023, and the progress of the 2024 expedition, which resulted in the total number of installed optical modules reaching 4000;

— successful continuation of experiments at the Superheavy Element Factory, in particular, the observation of two events of the new isotope ^{288}Lv in the ^{54}Cr + ^{238}U reaction, which is also an important stage in preparation to the synthesis of the new element 120 in the ^{54}Cr + ^{248}Cm reaction;

— development of the DRIBs-III accelerator complex with the modernization of the U-400M cyclotron, construction of the DC-140 accelerator and the U-400R new experimental hall;

— implementation of the working plan to prepare for regular operation of the IBR-2 reactor and the development of the complex of spectrometers, in particular, the wide-aperture backscattering detector (BSD-A) for the high-resolution Fourier diffractometer, small-angle neutron scattering detector (SANSARA), and inelastic neutron scattering spectrometer in inverse geometry (BJN);

— active development of fundamental and applied areas of research related to life sciences and condensed matter physics due to the development

Dubna, 22–23 March. Session of the JINR CP

of the interlaboratory research programme, in particular, at LRB;

— important results in the field of theoretical physics of elementary particles and atomic nucleus, condensed matter physics, and advanced mathematical physics, aimed, in particular, at supporting the JINR experimental programme;

— successful development of the MICC JINR, including an increase in the power of the Govorun supercomputer, and the significant reorientation of the DIRAC distributed platform to the support of the MPD, BM@N and SPD experiments, as well as research at the Baikal-GVD neutrino telescope.

The Committee of Plenipotentiaries took note of the information on the fulfilment of the CP instruction of November 2023, issued due to the restriction of the activities of STRABAG JSC on the territory of the Russian Federation, and the transfer of the rights and obligations of the general contractor under the general construction contract "Installation of the heavy-ion collider NICA at the site of VBLHEP JINR in Dubna with a partial reconstruction of building #1" of 18 September 2015 to TES LLC from 1 March 2024.

The Committee of Plenipotentiaries supported the efforts of the JINR Directorate to renew and develop the social infrastructure of JINR (the restaurant of the H&R Complex "Dubna", the complex of buildings on the territory of the Resort Hotel "Ratmino", the International Conference Hall) for the infrastructure support of the programme for the development of human resources of the Institute in accordance with the current Seven-Year Plan for the Development of JINR.

The Committee of Plenipotentiaries supported the initiative of the JINR Directorate to create an International Innovation Park of Science and Technology in Dubna, including, in particular, the construction of a modern university campus and comprehensive development of the surrounding areas, together with technologically advanced partners from JINR Member States and partner countries, the SEZ "Dubna", regional and federal executive authorities, and Dubna State University.

The Committee of Plenipotentiaries expressed gratitude to the IAEA and the JINR Directorate for supporting the initiative to hold a two-week internship at JINR within the framework of the IAEA Lise Meitner Programme in agreement with the IAEA.

The Committee of Plenipotentiaries endorsed JINR's intensified participation in the International Decade of Basic Sciences for Sustainable Development (IDBSSD) under the auspices of UNESCO through JINR's accession to the Earth Charter.

The Committee of Plenipotentiaries supported the JINR Directorate in their efforts to develop the international scientific and technical cooperation and create an integrated scientific and technological space in the field of neutron research at the unique neutron sources, including research infrastructure of the megascience class.

The Committee of Plenipotentiaries endorsed the accession of the Joint Institute for Nuclear Research to the Consortium for the project to develop an International Research Centre based on the multipurpose fast research reactor MBIR and to the international association "Interdisciplinary Centre for Neutron Research PIK" under conditions that take into account the special status of the Institute and the Seven-Year Plan for the Development of JINR for 2024–2030, as well as the interests of the JINR Member States.

Dubna, 22–23 March. Participants of the JINR CP session

The Committee of Plenipotentiaries supported the initiative of the JINR Directorate to establish a new scientific journal published by JINR and recomended that preparations for the launching of the journal be intensified.

The Committee of Plenipotentiaries congratulated the staff of the Institute on the 40th anniversary of the commissioning of the IBR-2 pulsed neutron source, supporting the initiative of the JINR Directorate and the Frank Laboratory of Neutron Physics on naming the square near the IBR-2 reactor building at the JINR DLNP site after V. Ananyev.

Having heard and discussed the report "Execution of the JINR budget for 2023 and draft of the revised budget of JINR for 2024" presented by N. Kalinin, Head of the JINR Budget and Economic Policy Department, the Committee of Plenipotentiaries approved the revised budget of JINR for 2024 with the income amounting to US$214 124.5 thousand and the expenditure amounting to US$286 818.2 thousand, taking into account the positive opening balance amounting to US$56 749.0 thousand, as well as the new forms of reports on the execution of the JINR budget.

The Committee of Plenipotentiaries took note of the information about the contribution arrears to the JINR budget of the states that withdrew from the JINR membership in 2022. As of 31 December 2022, the arrears of the Czech Republic were recorded in the amount of US$4182.3 thousand, the arrears of Ukraine were US$11 117.4 thousand, including restructured arrears of US$315.6 thousand. The Republic of Poland has no arrears.

Having heard and discussed the report "Results of the meeting of the JINR Finance Committee held on 21 March 2024" presented by A. Omelchuk, Chair of the Finance Committee, the Committee of Plenipotentiaries approved the Protocol of the meeting and took note of the information from the Plenipotentiary of the Government of the Socialist Republic of Vietnam that the amount of contribution of Vietnam planned to be paid in 2024 will not exceed the contribution of Vietnam for 2023 plus 5%.

The Committee of Plenipotentiaries instructed the JINR Directorate and the Working Group under the CP Chair for JINR Financial Issues to develop an approach to determining the annual contributions of the Member States, taking into account the annual increase in the JINR budget by 5% during the implementation of the Seven-Year Plan for the Development of JINR for 2024–2030 and the issue of abolishing the Rule for the lower limits of contributions starting in 2025, and submit their proposals for consideration at the meeting of the Finance Committee and the CP session in November 2024.

The Committee of Plenipotentiaries took note of the information as presented by the JINR Directorate about the selection of an organization for auditing JINR's financial activities for 2023 and approved the LLC JSC "Korsakov and Partners" as JINR's auditor and the Plan for auditing the financial activities of JINR for 2023 as presented by the JINR Directorate.

Having heard and discussed the report "On amendments proposed to the Rules of Procedure of the Finance Committee and the Rules of Procedure of the Committee of Plenipotentiaries of JINR" by A. Kharevich, Head of the JINR Legal Department, the Committee of Plenipotentiaries approved the new editions of the Rules of Procedure of the JINR Finance Committee.

Having heard and discussed the report "On the status of preparation and approval of the List of JINR officials" by A. Kharevich, the Committee of Plenipotentiaries preliminarily endorsed the presented draft List of JINR officials, instructing the JINR Directorate to send the draft List of JINR officials to Plenipotentiaries of the Governments of the JINR Member States and to ask the Plenipotentiaries to further develop the issue of approval of the List of JINR officials with the relevant bodies and departments of the JINR Member States in time for its consideration at the CP session in November 2024.

Having heard and discussed the report "On the decision of the Republic of Moldova to withdraw from JINR" by the Chair of the Committee of Plenipotentiaries, A. Khvedelidze, the Committee of Plenipotentiaries took note of the notification of the Republic of Moldova on its withdrawal from the Joint Institute for Nuclear Research and instructed the CP Chair to notify the Republic of Moldova about maintaining its full membership in the Joint Institute for Nuclear Research during 2024 and the entry into force of its withdrawal from JINR from 1 January 2025.

Having heard and discussed the report "Amendments to the Regulation for the election of Directors and for the endorsement of appointment of Deputy Directors of JINR Laboratories" presented by S. Nedelko, JINR Chief Scientific Secretary, the Committee of Plenipotentiaries approved the new edition of the Regulation.

SESSION OF THE COMMITTEE OF PLENIPOTENTIARIES, 15 November 2024

A regular session of the Committee of Plenipotentiaries of the Governments the Member States of the Joint Institute for Nuclear Research was held on 15 November in Minsk (Republic of Belarus), chaired by the Plenipotentiary of the Government of Georgia, A. Khvedelidze.

Having heard and discussed the report by the JINR Director, G. Trubnikov, the Committee of Plenipotentiaries took note of the information from the JINR Directorate about the implementation of the current Seven-Year Plan for the Development of JINR, the efforts of the Member States towards re-

alization of JINR's major projects, the new scientific and technological results obtained, and about the most important events related to scientific and educational activities and the development of JINR as an international scientific research organization.

The CP endorsed the systematic activities of JINR to strengthen cooperation with research organizations of the JINR Member States and Associate Members, noting with particular satisfaction the growing level and effectiveness of cooperation between scientific and scientific and educational organizations of the Republic of Belarus and JINR, as well as the active role of Belarus in the implementation of the Institute's flagship projects, primarily, the NICA megaproject.

The Committee of Plenipotentiaries noted with gratitude the high level of attention of the Russian Federation to the creation of favourable conditions for the work of JINR and the implementation of the international megascience project NICA. Evidence of this was the visit of the President of the Russian Federation Vladimir Putin in June 2024 to JINR and his strategic support for the activities of JINR with regard to the development of international scientific and technical cooperation, his meeting with scientists from JINR Member States and discussion of the Institute's achievements, initiation of the technological launch of the NICA complex, as well as holding a meeting of the Council for Science and Education under the President of the Russian Federation at JINR.

The CP accepted with satisfaction the decision of the CERN Council not to terminate the agreement on international cooperation with JINR, and expressed hope for the earliest possible resumption of full-scale participation of JINR in CERN activities, as well as of CERN in JINR activities.

The Committee of Plenipotentiaries expressed particular satisfaction with the signing of the agreement between JINR and the Ministry of Science and Technology of the People's Republic of China on the launch of eight joint projects, and strongly supported the strengthening of cooperation with government bodies, scientific organizations, and universities in Mexico and India. The CP welcomed the signing of a cooperation agreement between the National Nuclear Energy Commission (CNEN) of Brazil and JINR, which opens up great prospects for increasing the level of Brazil's participation in JINR.

The CP noted with satisfaction the progressive development of the accelerator complex of the Veksler and Baldin Laboratory of High Energy Physics:

— completion of the installation of the magnetic cryostat system of the NICA collider;

— completion of the commissioning work of technological equipment of the cryogenic compressor station;

— successful completion of cryogenic tests of the MPD superconducting solenoid and the start of its cooling to operating temperature (liquid helium temperature);

— successful completion of the technical design of the SPD detector and the start of work on the construction of its basic elements;

— beginning of a cycle of technological tests of the collider, which was launched by the President of the Russian Federation Vladimir Putin during his visit to the NICA accelerator complex.

The Committee of Plenipotentiaries welcomed the progress of the experimental programme in the field of nuclear physics and the modernization of the accelerator complex of the Flerov Laboratory of Nuclear Reactions:

— continuation of experiments at the Superheavy Element Factory aimed, first of all, at preparing experiments on the synthesis of elements 119 and 120 with ^{54}Cr and ^{50}Ti beams;

— completion of the upgrade of the U-400M accelerator. Ion beams of ^{16}O, ^{40}Ar, ^{132}Xe have been accelerated and transported, work continues to achieve the accelerator's design parameters. The first experiment on ^{6,8}He beams has been prepared and launched;

— planned pace of constructing the new U-400R experimental hall.

The CP noted progressive development of the Baikal-GVD deep-water neutrino telescope in 2024, with the total number of installed optical modules reaching 4104, as well as significant improvement of the Baikal-GVD shore infrastructure.

The Committee of Plenipotentiaries emphasized the importance of the Institute's contribution to the work of major international collaborations:

— successful participation of JINR in the work of the CERN collaborations at the LHC on the second phase of upgrading the ATLAS, CMS, and ALICE detectors, as well as obtaining new results in the CERN-SPS experiments;

— efficient work of the JINR group in the first phase of the COMET experiment at J-PARC (Japan).

The CP noted with satisfaction the efficient operation and development of the JINR MICC, including the Govorun supercomputer, a significant increase in the tape data storage capacity from 50 to 90 PB, as well as successful work of the JINR grid centres for the NICA experiments on the resources of the Govorun supercomputer, Tier1 and Tier2 using the DIRAC distributed computing platform, and welcomed ranking the JINR Tier1 centre first among Tier1 world centres for the CMS experiment by the CPU time for data processed in 2024.

The Committee of Plenipotentiaries took note, with satisfaction, of the information on obtaining a license from the supervisory authority for the operation of the IBR-2 reactor, the preparatory work underway at the Frank Laboratory of Neutron Physics to start the reactor, and the plans to begin experiments on external beams in spring 2025.

The CP noted new interesting results in the field of theoretical physics, oriented towards the JINR experimental programmes, in particular, in the field of nuclear physics of superheavy elements and the physics of critical phenomena in collisions of relativ-

Minsk (Belarus), 15 November. Session of the JINR CP

Minsk (Belarus), 15 November. Head of the VBLHEP JINR Sector of Track Detectors S. Movchan was awarded the Honorary Certificate of the State Committee for Science and Technology of the Republic of Belarus

Minsk (Belarus), 15 November. JINR Vice-Director L. Kostov was awarded the Order of Friendship by the Decree of the President of the Russian Federation

istic heavy ions and the development of the interlaboratory programme of fundamental and applied research in life sciences, in particular, new results in medical radiobiology, bioinformatics, and astrobiology obtained at the Laboratory of Radiation Biology.

The Committee of Plenipotentiaries approved the Director's initiative to organize a programme for the support of interlaboratory innovative projects with the aim of stimulating applied scientific research and innovative developments at JINR, more active involvement of young scientists and engineers of the Institute in this activity, development of active interaction with the high-tech industry of the JINR Member States.

The CP supported the active scientific and educational activities of the JINR University Centre and the JINR laboratories, aimed, in particular, at increasing the motivation of physics teachers and talented students of high schools in the JINR Member States.

The Committee of Plenipotentiaries noted with satisfaction the successful work of the JINR Dissertation Councils in improving the qualifications of researchers from the Institute and organizations in the Member States, the successful implementation of the JINR Postdoctoral and Fellowship programmes.

The CP endorsed the work done by the JINR Directorate and the specially organized working group in preparation for the opening of the new scientific journal "Natural Science Review", which will be published by JINR, and recommended that JINR Member States and JINR partners provide proactive assistance to the JINR Directorate in popularizing this journal by all means available to them.

The Committee of Plenipotentiaries welcomed the joint development with the Government of the Russian Federation of amendments to the Agreement between the Government of the Russian Federation and the Joint Institute for Nuclear Research on the Location and Terms of Activity of the Joint Institute for Nuclear Research in the Russian Federation, signed in Dubna, Moscow Region, on 23 October 1995.

The CP agreed with the proposals of the JINR Directorate for the development of an attractive and competitive remuneration system at the Institute, including an increase in the personnel costs of the JINR budget for 2025, as well as measures for additional motivation for advanced training and professional growth of scientific workers and specialists.

The Committee of Plenipotentiaries endorsed the actions of the JINR Directorate to develop the JINR social infrastructure and the city area of Dubna, aimed at creating favorable living conditions for the Institute's employees and their families.

The CP supported the proposals of the JINR Directorate on the need to organize preparations for the JINR anniversary events in 2026 that will enable the popularization of scientific achievements of the JINR Member States and the Institute itself, as well as world achievements in fundamental science, and expected the plan of events for 2025–2026 dedicated to the 70th anniversary of JINR at the CP session in March 2025.

Having heard and discussed the report "On the progress of work on launching the basic configuration of the NICA complex and decisions of the Supervisory Board of the NICA project" by V. Kekelidze, Head of the NICA complex project, and taking note of:

— information on the timing of the construction and launch of the basic configuration of the NICA complex;

— information on the implementation of general construction contract No. 100/2795 of 18 September 2015 and the progress in the construction of the NICA complex;

— information on the increase in the scope of work underway;

— information on the forced decisions to change some suppliers, their financial consequences and the additional costs that arose in this regard;

— decisions of the IX and X meetings of the Supervisory Board of the NICA complex project,

the Committee of Plenipotentiaries:

— agreed with the presented working schedule for the construction and launch of the basic configuration of the NICA complex;

— agreed on the need to prepare and sign an additional agreement to general construction contract No. 100/2795 of 18 September 2015 for the construction of buildings and structures (capital construction objects) for the installation of the heavy-ion collider NICA at the site of JINR VBLHEP in Dubna, with a partial reconstruction of building No. 1, taking into account the current cost and timing of the work underway;

— endorsed the organizational and financial decisions made by the JINR Directorate to minimize the risks of non-implementation of the NICA complex project (hereinafter referred to as the Project) in 2022–2024, commissioning the JINR Directorate to continue this work and ensure taking decisions and measures to maintain the Project schedule and the main parameters of the complex and to continue active claims work with unfair suppliers;

— commissioned the JINR Directorate to estimate the forecasted cost of the Project and to present a justified updated cost of the Project at the CP session in March 2025;

— welcomed the joint development with the Government of the Russian Federation of amendments to the Agreement between the Government of the Russian Federation and the International Intergovernmental Scientific Research Organization Joint Institute for Nuclear Research on the construction and exploitation of the NICA complex of superconducting rings for heavy-ion colliding beams of 2 June 2016, aimed at updating the deadlines and cost of implementing the project for the construction and exploitation of the NICA complex, as well as raising the status of decisions of the Supervisory Board of the Project.

Having heard and discussed the report "Draft budget of JINR for the year 2025, provisional contributions of the Member States for the years 2026, 2027, 2028" by N. Kalinin, Head of the JINR Budget and Economic Policy Department, the Committee of Plenipotentiaries:

— approved the JINR budget for 2025 with the income amounting to US$229 017.7 thousand and the expenditure amounting to US$276 600.3 thousand with the closing negative balance amounting to US$47 582.6 thousand;

— authorized the Director of JINR to make adjustments to the JINR budget for 2025 including adjustments to the personnel remuneration and costs for international cooperation within the approved budget in compliance with the Regulations for the Introduction of Adjustments to the Budget of JINR;

— approved the contributions of the JINR Member States for the year 2025 with an increase of 5% compared to 2024, with the exception of the Arab Republic of Egypt, which pays contributions to the JINR budget until 2028 based on the schedule of gradual entry into the payment of contributions;

— approved the provisional contributions of the JINR Member States for the years 2026, 2027, 2028;

— approved the budget for the year 2025 on the construction and exploitation of the NICA complex

of superconducting rings for heavy-ion colliding beams with the special-purpose funds of the Russian Federation, provided in accordance with the Agreement between the Government of the Russian Federation and JINR, in the amount of 1 486 726.7 thousand rubles;

— approved the consolidated adjustment of the JINR budget for the year 2024 over 9 months;

— authorized the Director of JINR to index the salary and tariff parts of the remuneration package of the Institute's employees, taking into account the needs and possibilities of the JINR budget for 2025, in accordance with the JINR Collective Bargaining Agreement for 2023–2026;

— emphasized the importance of finding joint solutions, in the current geopolitical conditions, regarding the payment of contributions by the Member States to the JINR budget.

Having heard and discussed the report "Results of the meeting of the JINR Finance Committee held on 14 November 2024" presented by A. Omelchuk, Chair of the Finance Committee, the CP approved the Protocol of the meeting of the Finance Committee held on 14 November 2024 and, in order to ensure stable financial support for the implementation of the Seven-Year Plan for the Development of JINR for 2024–2030, determined the amount of contributions of the Member States for 2025–2030 by annually increasing the contribution of each Member State by 5%. For the Arab Republic of Egypt, taking into account the approved schedule of gradual entry into payment of the contribution, this method of calculating the contribution shall be used from 2028.

The Committee of Plenipotentiaries commissioned the Working Group under the CP Chair for JINR Financial Issues to work out and formulate proposals for the development of instruments of JINR's financial policy and attracting additional special-purpose funds, which will facilitate the implementation of joint scientific, educational, and infrastructure public-private projects of the JINR Member States and JINR partner countries.

The CP commissioned the JINR Directorate and the Working Group under the CP Chair for JINR Financial Issues to further improve the current methodology for calculating the contributions of the Member States for its application after 2030.

The Committee of Plenipotentiaries maintained the effect of the Rule for the lower limits of contributions until the approval of a new version of the methodology for calculating the contributions of the Member States, approved the audit report based on the results of the audit of JINR's financial activities for the year 2023.

Having heard and discussed the report "On approval of the List of JINR officials" by the CP Chair, A. Khvedelidze, the Committee of Plenipotentiaries approved the List of JINR officials annexed to the Agreement between the Government of the Russian Federation and the Joint Institute for Nuclear Research on the Location and Terms of Activity of the Joint Institute for Nuclear Research in the Russian Federation, signed in Dubna, Moscow Region, on 23 October 1995, commissioned the JINR Directorate to conduct negotiations with the Government of the Russian Federation to agree on the approved List of JINR officials and authorized the JINR Director to sign the List of JINR officials, approved and agreed with the Government of the Russian Federation, on behalf of the Joint Institute for Nuclear Research.

Having heard and discussed the report "Recommendations of the 136th session of the JINR Scientific Council (September 2024)" presented by S. Nedelko, Chief Scientific Secretary of JINR, taking into account the information presented in the report of JINR Director G. Trubnikov, the Committee of Plenipotentiaries took note of the information from the JINR Directorate on the recommendations of the 136th session of the JINR Scientific Council, approved the recommendations of the 135th and 136th sessions of the JINR Scientific Council and approved the Topical Plan for JINR Research and International Cooperation for 2025.

Having heard and discussed the report "Changes in the membership of the JINR Scientific Council" presented by G. Trubnikov, Director of JINR, the Committee of Plenipotentiaries elected Raghunath Sahoo (Indian Institute of Technology Indore, Indore, India) and Yuntao Song (Institute of Plasma Physics of the Chinese Academy of Sciences, Hefei, People's Republic of China) as members of the JINR Scientific Council for the term of office of the current membership of the Scientific Council.

Having heard the scientific report by S. Maksimenko, Director of the Institute for Nuclear Problems of the Belarussian State University, on the main research areas of this institute and potential for cooperation, the CP expressed its gratitude to Professor S. Maksimenko for his interesting and informative report.

The Committee of Plenipotentiaries thanked the organizers and the Plenipotentiary of the Government of the Republic of Belarus to JINR for the high level of preparation and holding of the CP session.

SCIENTIFIC COUNCIL

135th SESSION OF THE JINR SCIENTIFIC COUNCIL, 15–16 February 2024

The 135th session of the JINR Scientific Council was held on 15–16 February. It was chaired by JINR Director G. Trubnikov and Deputy Chairman of the Presidium of the National Academy of Sciences of Belarus S. Kilin.

G. Trubnikov presented a comprehensive report highlighting the decisions of the JINR Committee of Plenipotentiaries session (9–10 November 2023), the results of the implementation of the Seven-Year Plan for the Development of JINR for 2017–2023, the progress in the realization of the projects included in the Topical Plan for 2024, as well as recent events in JINR's international cooperation.

The Scientific Council heard information on the work of the JINR Programme Advisory Committees presented by I. Tserruya (PAC for Particle Physics), V. Nesvizhevsky (PAC for Nuclear Physics), and D. L. Nagy (PAC for Condensed Matter Physics).

A new edition of the Regulation for the election of Directors and for the endorsement of appointment of Deputy Directors of JINR Laboratories, proposed by the JINR Directorate, was presented to the Scientific Council.

The award of the title of Honorary Doctor of JINR was announced at the session. The positions of DLNP and FLNP Deputy Directors were approved. A vacancy was announced for the position of FLNR Director.

The reports of young scientists recommended by the PACs were heard.

The Scientific Council approved the decision of the jury to award the annual JINR prizes for the best scientific research theoretical and experimental works, scientific and methodology, and scientific and technology works, as well as scientific and technology applied works.

The Scientific Council adopted the following resolution.

General Considerations

According to the report by the JINR Director, G. Trubnikov, the Scientific Council appreciated with satisfaction the impressive results in developing JINR's large research infrastructure, the Institute's significant contribution to international cooperation, especially at CERN, as well as JINR's recent achievements:

— completion of the production and cryogenic testing of components of the collider's magnetic system, readiness for commissioning the power supply system for the structural elements of the collider, preparations for the launch of a new cryogenic compressor station, beginning of the implementation of an educational programme to train operators involved in commissioning and operation of the NICA complex;

— progress in the reconstruction of raw experimental data recorded by the BM@N experiment, in particular, the reconstruction of statistically significant signals of Λ and Ξ hyperons and K^0_s meson for further physics analysis;

— progress in the production of all components of the MPD first-stage detector with minimal delays;

— presentation of the updated SPD Technical Design Report (TDR) at the PAC meeting in January 2024 and the start of a review process of the updated TDR by the new international Detector Advisory Committee (DAC) appointed in December 2023;

— development of the ARIADNA collaboration, whose applied research programme was launched at the NICA complex at the beginning of 2023, testing of the SOChI station with the Ar beam, and installation of two other stations — SIMBA and ISCRA;

— successful participation of the Institute in the work of collaborations at CERN, as well as the high level of JINR's activity in the fulfilment of its obligations under the programme for the second phase of upgrade of the ATLAS, CMS, and ALICE detectors;

— progress in developing the Baikal-GVD deep-water neutrino telescope, installation of 576 optical modules and two bottom cable lines in 2023, as well as manufacturing 470 optical modules for installation during the 2024 expedition;

— successful continuation of experiments at the Superheavy Element Factory, in particular, the observation of two events of the new isotope ^{288}Lv in the ^{54}Cr + ^{238}U reaction, which is also an important stage in preparation to the synthesis of the new element 120 in the ^{54}Cr + ^{248}Cm reaction;

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— progress in developing the DRIBs-III accelerator complex with the modernization of the U-400M cyclotron with the first beam expected in the spring of 2024, the progress of construction work for the DC-140 with commissioning expected at the end of 2024, as well as the planned implementation of the construction work in the new experimental hall of U-400R;

— successful implementation of the working plan to prepare for continuing the regular operation of the IBR-2 reactor, and progress in the development of the spectrometer complex, in particular, the wide-aperture backscattering detector (BSD-A) for the high-resolution Fourier diffractometer, small-angle neutron scattering/neutron radiography detector (SANSARA), and an inelastic neutron scattering spectrometer in inverse geometry (BJN);

— further active development of fundamental and applied areas of research related to life sciences and condensed matter physics due to the development of the interlaboratory research programme at LRB;

— successful work of BLTP and important results in particle, nuclear, condensed matter physics, and advanced mathematical physics, aimed, in particular, at theoretical support of the JINR experimental programme;

— successful development of the MICC JINR, including the expansion of the Govorun supercomputer, the use of the DIRAC distributed platform to support the collaborations of the NICA MPD, BM@N and SPD experiments, as well as the Baikal-GVD neutrino telescope.

Recommendations of the Programme Advisory Committees Taken at the Meetings in January 2024

The Scientific Council took note of the recommendations made by the PACs at their meetings in January 2024.

Particle Physics. The Scientific Council recognized the PAC's support for the adoption of the new Seven-Year Plan for the Development of JINR for 2024–2030 and the plans of the JINR Directorate to focus on the priority implementation of major projects, including the flagship megascience project NICA.

The Scientific Council congratulated the accelerator team of the NICA complex for the successful completion of the assembly of the ISCRA and SIMBO stations for applied research and the installation of the elements of the RF1 and RF2 systems in the NICA collider tunnel. The Scientific Council acknowledged the plan to fully complete the commissioning of the NICA cryogenic complex in August 2024, as well as the start of a personnel training programme in preparation for the collider's commissioning in 2025.

The Scientific Council noted the successful processing of the data recorded by the BM@N experiment in 3.8*A* GeV Xe + CsI collisions using the DIRAC system at the MLIT Tier-1/Tier-2 computers.

The Scientific Council appreciated the appointment of the international SPD Detector Advisory Committee (DAC) and the progress in forming the SPD collaboration. It supported the PAC's recommendation that the new DAC thoroughly review the updated TDR and present a report at the next PAC meeting.

The Scientific Council endorsed the recommendation of the PAC to extend for three years, until the end of 2027 with ranking A, the SCAN-3 project to study η- and Δ-nuclei formation at the Nuclotron, the ALPOM-2 project aimed at measuring the analyzing power of scattering reactions of polarized nucleons on various targets, and the DSS project to study the short-range spin structure of two- and three-nucleon correlations.

The Scientific Council concurred with the PAC in noting that commissioning of the NICA facility, together with the high priority given to the NICA flagship experiments — BM@N, MPD, and SPD, makes it questionable whether beam time will be available for other experiments, which may affect the timely realization of the SCAN-3, ALPOM-2, and DSS projects. The Scientific Council supported the PAC's recommendation that the VBLHEP and NICA managements define an overall strategy for the availability of beam time for users for the next 2–3 years.

The Scientific Council noted the proposal of a new project, "Fundamental and applied physics using beams of relativistic accelerated electrons (FLAP)", at the linear electron accelerator Linac-200. The Scientific Council endorsed the PAC's recommendation to open the new project FLAP for the period of 2025–2029 with ranking A.

The Scientific Council noted the proposal of a new project entitled "HyperNIS–SRC: HyperNuclear Intrinsic Strangeness and Short-Range Correlations". The Scientific Council seconded the PAC in supporting the proposed experiment with hypernuclei at the Nuclotron and the plans to expand the setup for the SRC study. It endorsed the recommendation to approve this project until the end of 2029 with ranking A.

The Scientific Council appreciated the contributions of the JINR teams participating in the LHC and SPS experiments on physical analyses and detector upgrades.

Nuclear Physics. The Scientific Council supported the work plan for scientific research and infrastructure development of JINR laboratories in the field of nuclear physics within the framework of themes and projects for 2024.

The scientific programme of the theme "Neutron Nuclear Physics" will be implemented under three projects: two scientific projects ("Investigations of neutron nuclear interactions and properties of the neutron" and "TANGRA"), and one scientific and technical project ("Modernization of the EG-5 accelerator and its experimental infrastructure").

Within the project "Investigations of neutron nuclear interactions and properties of the neutron", it is planned to resume measurements of angular correlations and γ-ray yields for already known *p*-wave resonances in various nuclei, and to search for new *p*-resonances and new effects promising violation of parity and *T* invariance. The main work is expected to be carried out at the IREN resonance neutron source.

In 2024, it is planned to carry out a study of resonance neutron capture in ^{176}Lu and ^{177}Lu in the neutron energy range of 1–300 eV. The goal of the experiment is to study the effect of the Coriolis interaction on the structure of nuclear excited states. Research for rare fission modes (ternary, quaternary, and quinary) of nuclei will be continued for neutron-induced fission of uranium isotopes ^{233}U and ^{235}U.

The area of interest of the "TANGRA" project is nuclear reactions induced by neutrons with an energy of about 14 MeV. The main areas of research in

2024 are: measurement of the (*n*, *xγ*) reaction cross sections for 22 elements for the elemental analysis, Monte Carlo simulations of nuclear instruments, and verification of theoretical calculations; measurement of the angular correlations of scattered neutrons and γ rays in inelastic neutron scattering on carbon.

Within the project "Modernization of the EG-5 accelerator and its experimental infrastructure", it is planned to replace the high-voltage system of the EG-5 facility, the main result of which will be an increase in the ion beam current from 2–3 to 100–250 μA, while maintaining its energy and spatial stability.

The Scientific Council supported the further implementation of the scientific programme for 2024 proposed within the theme "Neutron Nuclear Physics" and its projects.

The research programme at FLNR for 2024 of the theme "Synthesis and Properties of Superheavy Elements, Structure of Nuclei at the Limits of Nucleon Stability" will be implemented within two projects: "Investigation of heavy and superheavy elements" and "Light exotic nuclei at the borders of nucleon stability". The Scientific Council supported the scientific and technical programmes for 2024 under this theme and two projects.

The project "Investigation of heavy and superheavy elements" implemented at the SHE Factory will focus on the continuation of the $^{54}Cr + ^{238}U$ reaction experiment, which is extremely important for preparing the synthesis of new superheavy elements 119 and 120. It is planned to prepare and conduct the first experiments on the spectroscopy of isotopes of superheavy elements synthesized in the $^{48}Ca + ^{242}Pu$ reaction. The experiment will be carried out using the GRAND separator and the GABRIELA-2 detection setup comprised of five clover high-purity germanium γ detectors. It is expected to detect α decays of the even-even nucleus ^{286}Fl to the first excited state ^{282}Cn.

The main task of the project "Light exotic nuclei at the borders of nucleon stability" in 2024 will be the preparation and conduct of the first experiments aimed at studying the structure of light nuclei near the borders of nucleon stability at the ACCULINNA and ACCULINNA-2 fragment separators of the upgraded U-400M accelerator. Research will focus on studying the structure of heavy helium isotopes $^{6,7}He$ and the mechanisms of reactions leading to the formation of unbound exotic systems such as 4*n*.

The Scientific Council supported the JINR large research infrastructure (LRI) "Development of the FLNR Accelerator Complex and Experimental Setups (DRIBs-III)". In 2024, the main efforts within this LRI will be focused on:

— providing beams with the required characteristics for the implementation of FLNR's experimental programme at the existing accelerator complexes DC-280 (SHE Factory) and U-400;

— completing the upgrade and commissioning work at the U-400M accelerator, as well as ensuring first experiments with beams of radioactive nuclei;

— completing the construction of the DC-140 accelerator complex for applied heavy-ion investigations.

Under the project "Construction of the U-400R accelerator complex", the improvement of the technical parameters of the components of the upgraded U-400R accelerator, the construction of a new experimental hall, and the designing of novel setups for this experimental hall will continue.

The project "Development of the experimental setups to study the chemical and physical properties of superheavy elements" is aimed at developing the multi-reflection time-of-flight mass spectrometer and pre-separator GASSOL based on a gas-filled superconducting solenoid.

Areas of nuclear physics research at DLNP include both classical spectrometry of radioactive isotopes and the investigation of various rare phenomena by nuclear physics methods. The section "Nuclear Physics" of the JINR Topical Plan includes one of the major DLNP scientific themes, "Non-Accelerator Neutrino Physics and Astrophysics", which is aimed at searching for evidence of the existence of new physics beyond the Standard Model. There are three projects in the theme: "Nuclear spectrometry for the search and investigation of rare phenomena", "Investigations of reactor neutrinos on a short baseline", and "Radiochemistry and spectroscopy for astrophysics and nuclear medicine".

A significant part of the Laboratory's manpower is involved in the construction and commissioning of the Baikal-GVD gigaton volume neutrino telescope, which is part of the large research infrastructure of JINR.

The Scientific Council approved the presented plans for 2024 and recommended the continued support of the experiments conducted in the framework of the DLNP nuclear physics scientific programme.

Condensed Matter Physics. The Scientific Council took note of the status of obtaining a license to operate the IBR-2 facility and preparatory work to replace the air heat exchangers of the second cooling circuit of the reactor. Together with the PAC, the Scientific Council supported the FLNP's plans and efforts to restart the operation of the IBR-2 facility in 2024–2025.

The Scientific Council supported the PAC's recommendation to continue the activities on verifying the dynamics model of pulsed reactors, selecting the optimal configuration of the active core, and optimizing the design of the reactor vessel and reactivity modulator. The Scientific Council welcomed the ongoing development of a list of R&Ds to create a full-scale model of the reactor reactivity modulator, praising the development of the concept of a system for fast changing the working substance in the reactor's cryogenic chamber moderator. The Scientific Council also agreed with the PAC that the development of the scientific programme of the NEPTUN

reactor should be continued along with the ongoing activities within the large research infrastructure "Pulsed neutron source and the complex of spectrometers".

The Scientific Council was satisfied with the status of the Fourier stress diffractometer FSD at beamline 11A of the IBR-2 reactor. Relying on the opinion of the PAC, the Scientific Council noted that the achievements of FLNP in the development of the correlation diffractometry method would be very useful for designing instruments at new long-pulse neutron sources and supported further development of the method. The Scientific Council recommended applying the current procedures for the assessment of projects at JINR at future PAC meetings.

Reports by Young Scientists

The Scientific Council followed with interest the reports by young scientists, selected by the PACs for presentation at this session: "Development of technology for the production of double-sided silicon microstrip modules for upgrading the NICA BM@N Silicon Tracking System" by A. Sheremetiev (VBLHEP), "Enhanced directional extraction of very cold neutrons using a diamond nanoparticle powder reflector" by A. Nezvanov (FLNP), and "Origin of high-pressure phase transition in the $Ln_2Ti_2O_7$ (Ln = La, Nd, Pr) Carpy–Galy phases" by A. Asadov (FLNP).

Amendments to the Regulation for the Election of Directors and for the Endorsement of Appointment of Deputy Directors of JINR Laboratories

The Scientific Council endorsed the new edition of the Regulation for the election of Directors and for the endorsement of appointment of Deputy Directors of JINR Laboratories, proposed by the JINR Directorate, and recommended its approval at the next CP session in March 2024.

Awards and prizes

The Scientific Council approved the proposal of the JINR Director, G. Trubnikov, to award the title "Honorary Doctor of JINR" to Ch. Stoyanov (Bulgaria), as well as approved the Jury's recommendations presented by Vice-Director L. Kostov on awarding the JINR annual prizes for best papers in the fields of theoretical and experimental research, methodology and technology research, and applied technology research.

Election and Announcement of Vacancies in the Directorates of JINR Laboratories

The Scientific Council endorsed the appointment of A. Guskov as Deputy Director of the Dzhelepov Laboratory of Nuclear Problems (DLNP) until the completion of the term of service of the current DLNP Director, E. Yakushev. The Scientific Council endorsed the appointment of B. Mukhametuly as Deputy Director of the Frank Laboratory of Neutron Physics (FLNP) until the completion of the term of service of the current FLNP Director, E. Lychagin.

The Scientific Council announced the vacancy of the position of Director of the Flerov Laboratory of Nuclear Reactions. The election will take place at the 137th session of the Scientific Council in February 2025.

Due to the fact that the current VBLHEP Directorate is successfully operating at the final stage of constructing the NICA complex, it seems reasonable to give the VBLHEP team the opportunity to complete this stage with the existing staff and with the current distribution of responsibilities and management functions. In this regard, the Scientific Council agreed on the extension of the term of office of all Deputy Directors of VBLHEP until the election of the Director of VBLHEP.

136th SESSION OF THE SCIENTIFIC COUNCIL, 12–13 September 2024

The 136th session of the JINR Scientific Council was held on 12–13 September. It was chaired by JINR Director G. Trubnikov and Deputy Chairman of the Presidium of the National Academy of Sciences of Belarus S. Kilin.

G. Trubnikov presented a comprehensive report highlighting the decisions of the session of the JINR Committee of Plenipotentiaries (22 March 2024), the results of the implementation of the Seven-Year Plan for the Development of JINR for 2024–2030, the progress in the realization of the projects included in the Topical Plan for 2024, as well as recent events in JINR's international cooperation.

The Scientific Council heard information about the work of the JINR Programme Advisory Committees presented by I. Tserruya (PAC for Particle Physics), V. Nesvizhevsky (PAC for Nuclear Physics), and D. L. Nagy (PAC for Condensed Matter Physics).

A scientific report "The search for quark–gluon plasma at the Large Hadron Collider: What is next?" presented by Raghunath Sahoo (IIT Indore, India) was heard at the session.

Elections of the LRB Director were held, and vacancies for the positions of LRB Deputy Directors were announced.

The decisions on awarding the V. Dzhelepov Prize, the G. Flerov Prize, and the Oganesson Prize were announced. The presentation of the N. Bogoliubov Prize and the performance of the laureate took place.


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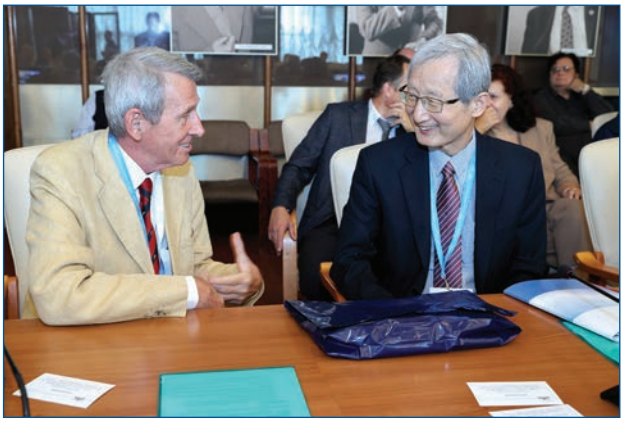

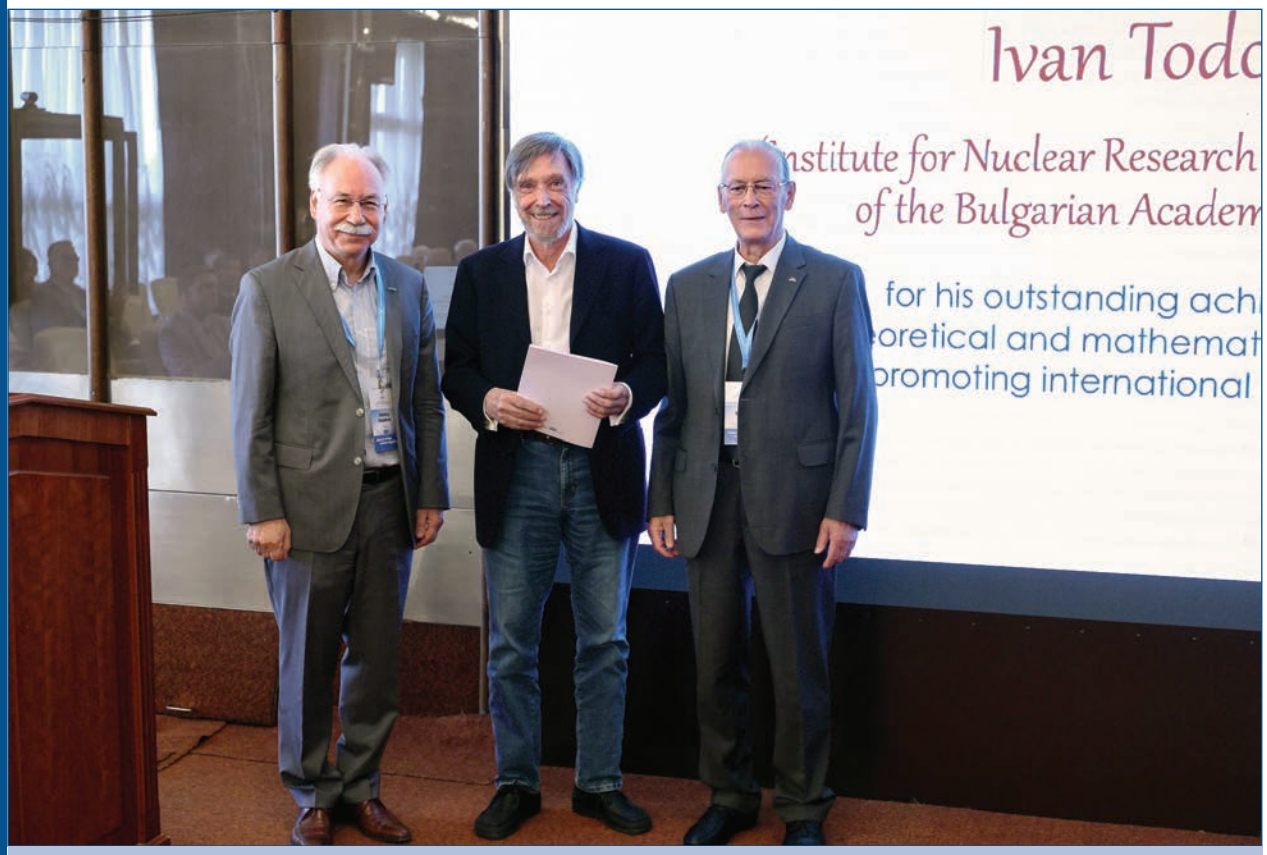

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The reports of young scientists recommended by the PAC were heard.

Diplomas were awarded to the winners of the JINR annual prizes for best scientific, methodological, technological, and applied research papers.

The Scientific Council adopted the following resolution.

General Considerations

Having heard the report of JINR Director G. Trubnikov, the Scientific Council approved JINR's activities to expand cooperation with research organizations of JINR Member States and Associate Members.

The Council noted with gratitude the high level of attention of the Russian Federation to the maintenance and development of favourable and fruitful conditions for the work of JINR, in particular, as a co-founding state and place of residence of the international megascience project NICA, as evidenced by the visit of the President of the Russian Federation V. Putin to JINR and holding of a meeting of the Council for Science and Education under the President of the Russian Federation at the Institute's site.

The Scientific Council appreciated the decision of the CERN Council to benefit further from the participation of JINR in CERN's activities and expressed confidence that scientists and the Directorates of CERN and JINR would ensure effective mutually beneficial cooperation despite the geopolitical complications.

The Scientific Council highly welcomed the signing of a high-level agreement between JINR and the Ministry of Science and Technology of the People's Republic of China (MOST) on the beginning of implementation of eight joint projects, and also strongly supported the ongoing strengthening of cooperation with Mexico, Brazil, and India.

The Scientific Council noted with satisfaction, in particular:

— progress of technological tests of the NICA collider ring, including installation of the collider magnetic cryostat system, two RF stations and final focusing lenses, the merging of the high-vacuum volume sections in the West and East arcs, installation of cryogenic equipment and power supplies in the collider building, connection of power lines and energy evacuation systems;

— striving to achieve the goal of detecting the first collisions of Xe beams in the MPD in August 2025;

— progress in the analysis of Λ and K^0_s production and collective flow of protons in Xe + CsI experimental data recorded by the BM@N experiment and publication of the BM@N detector paper in the journal "Nuclear Instruments & Methods in Physics Research";

— successful cooling of the MPD solenoid down to a temperature of 72 K, preparations for the analysis of the first data sets in fixed-target mode;

— finalization of the updated SPD Technical Design Report (TDR) and its approval at the PAC meeting in June 2024, progress in the development of detector prototypes;

— development of the ARIADNA collaboration and its research programme, preparation for the biosatellite experiment scheduled for 2025;

— progress in developing the Baikal-GVD deep-water neutrino telescope during the 2024 campaign that has resulted in the total number of installed optical modules reaching 4104 and 8 laser stations, as well as in significant improvement of the on-shore infrastructure;

— successful continuation of experiments at the Superheavy Element Factory aimed, first of all, at preparing experiments on the synthesis of elements 119 and 120 with ^{54}Cr and ^{50}Ti beams. The experimentally known region of the nuclear chart has been enlarged by the discovered isotopes ^{288}Lv, ^{289}Lv synthesized in the ^{50}Ti + ^{242}Pu and ^{54}Cr + ^{238}U reactions. The testing of a new large-diameter (480 mm) target will significantly speed up upcoming experiments on the spectroscopy of superheavy nuclei due to the possibility of having a twice larger beam current on a target;

— completion of the upgrade of the U-400M accelerator, acceleration and transportation of ^{16}O, ^{40}Ar, ^{132}Xe ion beams, continuation of work to reach the accelerator's design parameters and preparation for the first experiments scheduled for autumn 2024;

— rapid progress in the construction of the new experimental hall of U-400R and completion of the construction of a gallery from the U-400 cyclotron hall to the new experimental hall;

— preparatory work underway at FLNP to start the IBR-2 reactor after a long shutdown: obtaining a license for the operation of the IBR-2, replacing one of the two air heat exchangers, and work on replacing the second one. The technical readiness of the IBR-2 reactor for its start-up is scheduled for November 2024. Experimental work on external beams is scheduled for spring 2025;

— important results in fundamental and applied areas of research related to materials science and ecology carried out at FLNP, and in the field of life sciences due to the development of the interlaboratory research programme, in particular, at LRB;

— interesting results in the field of theoretical physics of elementary particles, atomic nuclei, condensed matter physics, and advanced mathematical physics, aimed, in particular, at supporting the JINR experimental programme;

— successful operation and development of the JINR Multifunctional Information and Computing Complex (MICC) and ranking the JINR Tier1 centre first among Tier1 world centres for CMS by the CPU time for data processed;

— successful participation of the Institute in the work of collaborations at CERN, including the second phase of the upgrade programme of the ATLAS, CMS, and ALICE detectors at the LHC complex, and new results in the experiments at SPS (CERN);

— efficient participation of the JINR group in the first phase of the COMET experiment at J-PARC (Japan).

Recommendations of the Programme Advisory Committees

The Scientific Council took note of the recommendations made by the PACs at their meetings in June 2024, as reported at this session by I. Tserruya, Chair of the PAC for Particle Physics, V. Nesvizhevsky, Chair of the PAC for Nuclear Physics, and D. L. Nagy, Chair of the PAC for Condensed Matter Physics.

Particle Physics. The Scientific Council appreciated the PAC's support for the plans of the Institute's Directorate to ensure full-fledged cooperation of scientists and specialists from the JINR Member States with CERN, as well as the efforts made to enhance ongoing cooperation and establish new scientific connections with China, India, Mexico, and Brazil.

The Scientific Council acknowledged the successful completion of the first stage of the NICA megascience project: commissioning of the injection complex of the collider, including the heavy-ion source KRION-6T, HILAC, Booster, Nuclotron, and beam transfer lines, and the start of the programme of fundamental and applied research at the fixed-target facilities. The launch of the experimental programme at the collider is planned for 2025 with a gradual increase in luminosity. The Scientific Council endorsed the PAC's recommendation to extend the Nuclotron–NICA project until the end of 2027 with ranking A.

The Scientific Council noted the progress in the production of the MPD first-stage detector and in the preparations of the MPD solenoid for magnetic field measurements planned for October 2024. The detector should be ready to move to the beam position by July 2025 to meet the NICA accelerator schedule. The Scientific Council also noted the first physics results obtained by the BM@N team from the data collected in 2023 on 3.8*A* GeV Xe + CsI collisions.

The Scientific Council appreciated the achievements of the SPD team in performing extensive R&D to prepare the conceptual and technical design reports of the detector, and thanked the SPD Detector Advisory Committee, which conducted a thorough review of the updated SPD TDR, and supported the PAC's recommendation to extend the SPD project until the end of 2029 with ranking A.

The Scientific Council endorsed the recommendation of the PAC to extend JINR's participation in the NA61/SHINE experiment at SPS CERN and in the STAR experiment at RHIC until the end of 2026 with ranking B.

Appreciating the success of the JINR team participating in the NA62 experiment aimed at studying rare kaon decays to test the Standard Model and refine the parameters of chiral perturbation theory, the Scientific Council supported the PAC's recommendation to continue JINR's participation in the NA62 experiment until the end of 2027 with ranking A.

The Scientific Council noted with satisfaction the important contribution made by the JINR group participating in the COMET project at J-PARC (Japan) to the development and construction of some main subdetector systems. The Scientific Council appreciated the participation of representatives of the JINR group in the management structures of the COMET collaboration and endorsed the PAC's recommendation to continue the participation of the JINR group in the COMET experiment until the end of 2029 with ranking A.

The Scientific Council supported the PAC's recommendation to open a new project "Development of a particle registration technique in future experiments with the participation of JINR", which is aimed at R&D for new detectors and novel methods for processing and analysing experimental data, for one year with ranking A.

The Scientific Council appreciated the contributions of the JINR teams participating in the LHC experiments (CERN) in physics analyses and detector upgrades.

Nuclear Physics. The Scientific Council noted the extensive work on the upgrade of the U-400M cyclotron, aimed at increasing the intensity and energy of heavy-ion beams, as well as improving the reliability and stability of the accelerator. The commissioning of the U-400M accelerator and first experiments using it are planned for the second half of 2024.

At the FLNR SHE Factory, experiments to synthesize isotopes ^{275,276}Ds in the ^{48}Ca + ^{232}Th reaction were continued, in which six decay chains of the new isotope ^{275}Ds were identified. ^{275}Ds was first produced in a reaction with ^{48}Ca and identified through sequential α decays leading to the known nuclei ^{271}Hs, ^{267}Sg, and ^{263}Rf previously synthesized in the ^{248}Cm(^{26}Mg, 3*n*)^{271}Hs reaction. For the first time, the new isotope ^{288}Lv was synthesized in the ^{238}U + ^{54}Cr reaction and the cross section of its formation was measured to be around 70 fb. The Scientific Council noted that the experiment with the ^{54}Cr beam is an important step for setting up experiments on the synthesis of elements with $Z > 118$. The Scientific Council recommended that work on the synthesis of the isotopes of superheavy elements and study of their decay properties be continued, in particular, using ^{54}Cr and ^{50}Ti beams.

The Scientific Council noted the important results obtained in the analysis of the first experiments carried out at the commissioned ACCULINNA-2 fragment separator conducted prior to upgrading the U-400M accelerator complex. In particular, these are new data on the low-energy spectra of the unbound nuclear systems 4*n*, $^{5–7}$H, ^{7,9}He, ^{8,10}Li produced in transfer reactions, with resolution of ^{6}H and ^{7}H ground states with extremely low cross sections.

In the course of experiments on the transfer reactions of neutrons, protons and α particles using ^{6,8}He radioactive beams and a cryogenic ^{2}H gas target, it is proposed to investigate the ^{4}He + ^{8}He reaction, which can provide additional data on the formation mechanism of the dineutron and tetraneutron.

Within the project "Nuclear bolometer", funded by the federal budget of the Russian Federation and

Rosatom, DLNP is involved in the development of low-temperature detection systems operating in the energy range below 1 eV. Agreeing that the development of the latest detection systems designed for the study of rare events in the domain of low energies is important and relevant, the Scientific Council highlighted that the project "Nuclear bolometer" does not require extra funding from JINR and endorsed the recommendations of the PAC for Nuclear Physics that the above-mentioned work be carried out as an activity within the theme "Non-Accelerator Neutrino Physics and Astrophysics".

Radiochemical research carried out at DLNP is implemented within the project "Radiochemistry and spectroscopy for astrophysics and nuclear medicine". The Scientific Council noted the following methods developed:

— production and purification of radionuclides for the synthesis of radiopharmaceuticals and manufacture of spectrometric sources;

— production of low-background materials with a uniquely low content of radioactive impurities;

— analysis of radiopharmaceuticals and their precursors, as well as the purity of resulting radioproducts and low-background materials.

The Scientific Council highly appreciated the radiochemical research carried out at DLNP, its high-quality and high-precision results, noted a significant contribution of this research to nuclear medicine, spectrometry and astrophysics, and recommended that work on radiochemical research be continued within of the project "Radiochemistry and spectroscopy for astrophysics and nuclear medicine".

Condensed Matter Physics. The Scientific Council welcomed the efforts of the FLNP team working on the development of a new neutron source and supported the main areas of this activity, including work to outline the suite of necessary instruments of the facility, develop models of reactor dynamics, and study the heating of the modulator elements and the reactor vessel. The Scientific Council shared the PAC's opinion on the need to continue work on the project for the development of the new neutron source.

The Scientific Council took note of the information on the progress of obtaining a license to operate the IBR-2 nuclear research facility and on the preparatory work to replace the air heat exchangers of the secondary cooling circuit of the reactor. The Scientific Council welcomed the intention of the FLNP Directorate to restart the operation of the IBR-2 nuclear research facility in 2024–2025 and resume the FLNP User Programme in 2025.

The Scientific Council endorsed the progress of instrument modernization at the IBR-2 reactor and noted the active preparations of instruments for the reactor start-up at the end of 2024. Two new scintillation detectors (ASTRA-M and BSD) have been installed on the IBR-2 beamlines and are ready for test measurements after the IBR-2 reactor starts its operation. The Scientific Council is also satisfied with the development of the BJN project and the activity on the SANSARA facility, and recommended that the creation of this installation continue.

The Scientific Council was pleased with the current state of the DN-6 diffractometer for the study of materials at ultrahigh pressures, in particular, a significant modernization of the instrument, which will improve the quality of experimental data. The Scientific Council shared the PAC's opinion on the continuation of the development of this instrument.

The Scientific Council supported the PAC's recommendations to open a new FLNR project, "High-sensitivity sensors based on molecular recognition for virus detection", for its implementation in 2025–2029, and to continue activities within the DLNP project "Protection against physical and chemical stresses with tardigrade proteins (TARDISS)".

Reports by Young Scientists

The Scientific Council followed with interest the reports by young scientists, selected by the PACs for presentation at this session: "Study of Λ-hyperon production in carbon collisions with solid targets in BM@N experiment" by K. Alishina (VBLHEP), "Real-time follow-up of multimessenger alerts at the Baikal-GVD telescope" by V. Dik (DLNP), and "Pressure effect on crystal, magnetic structure and vibrational properties of van der Waals materials" by O. Lis (FLNP). The Scientific Council thanked the speakers and welcomed such selected reports in the future.

Memberships of the PACs

The Scientific Council appointed A. Jaiswal (NISER, Bhubaneswar, India), L. Litov (Sofia University "St. Kliment Ohridski", Bulgaria), and G. Majumder (TIFR, Mumbai, India) as members of the PAC for Particle Physics for a term of three years.

The Scientific Council appointed N. V. Ravi Kumar (IIT Madras, Chennai, India) as a member of the PAC for Condensed Matter Physics for a term of three years.

Scientific Report

The Scientific Council heard with interest the scientific report "The search for quark–gluon plasma at the Large Hadron Collider: What is next?" presented by Raghunath Sahoo (IIT Indore, India) and thanked the speaker.

Awards and Prizes

The Scientific Council approved the Jury's recommendations on the award of the V. Dzhelepov Prize to M. Frontasyeva (FLNP JINR) for her significant contribution to the development of the international programme on the assessment of air quality using neutron activation analysis.

The Scientific Council approved the Jury's recommendations on the award of the G. Flerov Prize to:

Dubna, 13 September. At the 136th session of the JINR Scientific Council, the names of the winners of the 2024 Oganesson Prize were announced

— Academician R. Ilkaev (All-Russian Scientific Research Institute of Experimental Physics, VNIIEF), co-author of the discovery of element 114 (flerovium), for his great contribution to the synthesis and study of the properties of superheavy nuclei;

— E. D. Donets (VBLHEP JINR), E. E. Donets (VBLHEP JINR), and Zhao Hongwei (Institute of Modern Physics, Chinese Academy of Sciences) for the development of sources of highly charged ions to produce intense accelerated beams of medium and high energies.

The Scientific Council approved the Jury's recommendations on the award of the N. Bogoliubov Prize to Á. de Rújula (CERN) and I. Todorov (INRNE BAS) for their outstanding achievements in theoretical and mathematical physics and promoting international cooperation.

The Scientific Council thanked Á. de Rújula for his brilliant presentation.

The Scientific Council welcomed the Jury's decision presented by the JINR Director, G. Trubnikov, to award the Oganesson Prize to T. Chernigovskaya, G. Knyazheva, A. Nurmukhanbetova, Z. Vilakazi, and Yu. Zolotov.

The Scientific Council congratulated the winners of JINR annual prizes for best scientific, methodological, technological, and applied research papers.

Election and Announcement of Vacancies in the Directorates of JINR Laboratories

The Scientific Council elected A. Bugay as Director of the Laboratory of Radiation Biology (LRB) for a second term of five years. The vacancies were announced for positions of LRB Deputy Directors, which will be approved at the 137th session of the Scientific Council in February 2025.

FINANCE COMMITTEE

MEETING OF THE JINR FINANCE COMMITTEE, 21 March 2024

A regular meeting of the Finance Committee was held on 21 March in Dubna under the chairmanship of the representative of the Russian Federation A. Omelchuk.

Regarding the report by G. Trubnikov, JINR Director, the Finance Committee recommended that the Committee of Plenipotentiaries take note of the information from the JINR Directorate about the recommendations of the 135th session of the JINR Scientific Council, the implementation of the current Seven-Year Plan for the Development of JINR, the efforts of the Member States towards realization of JINR's major projects, the new scientific and technological results obtained, and about the most important events related to JINR's scientific research and educational activities and international cooperation.

The Finance Committee recommended that the Committee of Plenipotentiaries endorse the active implementation of the current plan for research and development of the large research infrastructure of JINR, the successful participation of the Institute in international collaborations, and achievements in strengthening international cooperation:

— completion of the production and cryogenic testing of components of the collider's magnetic system, readiness for commissioning the power supply system for the structural elements of the collider, preparations for the launch of a new cryogenic compressor station, beginning of the implementation of an educational programme to train operators involved in commissioning and operation of the NICA complex;

— progress in the production of all components of the MPD first-stage detector with minimal delays;

— start of reviewing the updated technical design of the SPD detector (TDR) by the new international expert committee on detectors (Detector Advisory Committee, DAC) appointed in December 2023;

— development of the ARIADNA collaboration, installation of two new stations, SIMBA and ISCRA, in addition to the SOChI station;

— progress in developing the Baikal-GVD deep-water neutrino telescope, the success of the 2024 expedition, which brought the total number of installed optical modules to 4000;

— development of the DRIBs-III accelerator complex with the modernization of the U-400M cyclotron, construction of the DC-140 accelerator and the U-400R new experimental hall;

— implementation of the working plan to prepare for regular operation of the IBR-2 reactor and the development of the complex of spectrometers, in particular, the wide-aperture backscattering detector (BSD-A) for the high-resolution Fourier diffractometer, small-angle neutron scattering detector (SANSARA), and inelastic neutron scattering spectrometer in inverse geometry (BJN);

— successful development of the MICC JINR, including an increase in the power of the Govorun supercomputer, and the significant reorientation of the DIRAC distributed platform to the support of the MPD, BM@N and SPD experiments, as well as research at the Baikal-GVD neutrino telescope.

The Finance Committee recommended that the Committee of Plenipotentiaries note the information on the fulfilment of the CP instruction of November 2023, issued due to the restriction of the activities of STRABAG JSC on the territory of the Russian Federation, and the transfer of the rights and obligations of the general contractor under the general construction contract "Installation of the heavy-ion collider NICA at the site of VBLHEP JINR in Dubna with a partial reconstruction of building #1" of 18 September 2015 to TES LLC from 1 March 2024.

The Finance Committee recommended that the Committee of Plenipotentiaries support the efforts of the JINR Directorate to renew and develop the social infrastructure of JINR (the restaurant of the H&R Complex "Dubna", the complex of buildings on the territory of the Resort Hotel "Ratmino", the International Conference Hall) for the infrastructure support of the programme for the development of human resources of the Institute in accordance with the current Seven-Year Plan for the Development of JINR.

Regarding the report "Execution of the JINR budget for 2023 and draft of the revised budget of JINR for 2024" by N. Kalinin, Head of the JINR Budget and Economic Policy Department, the Finance Committee recommended that the Committee of

Dubna, 21 March. Meeting of the JINR Finance Committee

Plenipotentiaries approve the revised budget of JINR for 2024 with the income amounting to US$214 124.5 thousand and the expenditure amounting to US$286 818.2 thousand, taking into account the positive opening balance amounting to US$56 749.0 thousand, as well as to approve the new forms of reports on the execution of the JINR budget.

The Finance Committee recommended that the Committee of Plenipotentiaries take note of the information about the contribution arrears to the JINR budget of the states that withdrew from the JINR membership in 2022. As of 31 December 2022, the arrears of the Czech Republic were recorded in the amount of US$4182.3 thousand, the arrears of Ukraine were US$11 117.4 thousand, including restructured arrears of US$315.6 thousand. The Republic of Poland has no arrears.

Regarding the report "Proposal for selecting an organization for auditing JINR's financial activities for the year 2023" by L. Kostov, JINR Vice-Director, the Finance Committee recommended that the Committee of Plenipotentiaries approve the LLC JSC "Korsakov and Partners" as JINR's auditor and the Plan for auditing the financial activities of JINR for 2023, as presented by the JINR Directorate.

Regarding the report "Results of the meeting of the Working Group under the CP Chair for JINR Financial Issues held on 15 January 2024" by Ye. Mukhamejanov, Chair of the Working Group under the CP Chair for JINR Financial Issues, the Finance Committee recommended that the Committee of Plenipotentiaries take note of the information from the Plenipotentiary of the Government of the Socialist Republic of Vietnam that the amount of contribution of Vietnam planned to be paid in 2024 would not exceed the contribution of Vietnam for 2023 plus 5%.

The Finance Committee recommended that the Committee of Plenipotentiaries commission the JINR Directorate and the Working Group under the CP Chair for JINR Financial Issues to develop an approach to determining the annual contributions of the Member States, taking into account the annual increase in the JINR budget by 5% during the implementation of the Seven-Year Plan for the Development of JINR for 2024–2030 and the issue of abolishing the Rule for the lower limits of contributions starting in 2025, and submit their proposals for consideration at the meeting of the Finance Committee and the CP session in November 2024.

Regarding the report "On amendments proposed to the Rules of procedure of the Finance Committee of JINR" by A. Kharevich, Head of the JINR Legal Department, the Finance Committee recommended that the Committee of Plenipotentiaries approve the new edition of the Rules of procedure of the JINR Finance Committee.

Regarding the report "On the status of preparation and approval of the List of JINR officials" by A. Kharevich, the Finance Committee recommended that the Committee of Plenipotentiaries preliminarily endorse the presented draft List of JINR officials and commission the JINR Directorate to send the draft List of JINR officials to Plenipotentiaries of the Governments of the JINR Member States for further development of the issue of approval of the List of JINR officials with the relevant bodies and departments of the JINR Member States.

The Finance Committee listened with interest to the report "Waiting for new physics", presented by D. Kazakov, BLTP Director, and thanked the speaker.

MEETING OF THE JINR FINANCE COMMITTEE, 14 November 2024

A regular meeting of the Finance Committee was held on 14 November in Minsk (Republic of Belarus) under the chairmanship of the representative of the Russian Federation A. Omelchuk.

Regarding the report by the JINR Director, G. Trubnikov, the Finance Committee recommended that the Committee of Plenipotentiaries take note of the information from the JINR Directorate about the recommendations of the 136th session of the JINR Scientific Council, the implementation of the current Seven-Year Plan for the Development of JINR, the efforts of the Member States towards realization of JINR's major projects, the new scientific and technological results obtained, and about the most important events related to JINR's scientific research and educational activities and international cooperation, and endorse the work carried out by the JINR Directorate on the execution of the JINR budget for the current year to implement the Topical Plan of JINR Research and International Cooperation in 2024.

The Finance Committee recommended that the Committee of Plenipotentiaries note with satisfaction progress in developing the new large research infrastructure:

— completion of the installation of the magnetic cryostat system of the NICA collider;

— completion of the commissioning work of technological equipment of the cryogenic compressor station;

— successful completion of cryogenic tests of the MPD superconducting solenoid and the start of its cooling to operating temperature (liquid helium temperature);

— successful completion of the technical design of the SPD detector and the start of work on the construction of its basic elements;

— beginning of a cycle of technological tests of the collider, which was launched by the President of the Russian Federation Vladimir Putin during his visit to the NICA accelerator complex;

— continuation of experiments at the Superheavy Element Factory aimed, first of all, at preparing experiments on the synthesis of elements 119 and 120 with ^{54}Cr and ^{50}Ti beams;

— completion of the upgrade of the U-400M accelerator. Ion beams of ^{16}O, ^{40}Ar, ^{132}Xe have been accelerated and transported; work continues to achieve the accelerator's design parameters. The first experiment on ^{6,8}He beams has been prepared and launched;

— planned pace of constructing the new U-400R experimental hall;

— progressive development of the Baikal-GVD deep-water neutrino telescope in 2024, with the total number of installed optical modules reaching 4104, as well as significant improvement of the Baikal-GVD shore infrastructure;

— steady development of the JINR MICC, including the Govorun supercomputer, a significant increase in the tape data storage capacity from 50 to 90 PB;

— obtaining a license from the supervisory authority for the operation of the IBR-2 reactor, preparatory work underway at the Frank Laboratory of Neutron Physics to start the reactor, and plans to begin experiments on external beams in spring 2025.

The Finance Committee recommended that the Committee of Plenipotentiaries endorse the activities of the JINR Directorate in developing the social and communications infrastructure of JINR, in particular, the establishment of an exhibition space on the basis of the JINR International Conference Hall and the expansion of the JINR museum complex to preserve the historical heritage of the Institute, demonstrate the achievements of the Institute and science in general, and popularize scientific, and scientific and technical activities among various target audiences.

The Finance Committee recommended that the Committee of Plenipotentiaries agree with the proposals of the JINR Directorate for the development of an attractive and competitive remuneration system at the Institute, including an increase in the personnel costs of the JINR budget for 2025.

Regarding the report "Results of the meeting of the Working Group under the CP Chair for JINR Financial Issues held on 4 July 2024" by Ye. Mukhamejanov, Chair of the meeting of the Working Group under the CP Chair for JINR Financial Issues, the Finance Committee recommended the following to the Committee of Plenipotentiaries:

— in order to ensure stable financial support for the implementation of the Seven-Year Plan for the Development of JINR for 2024–2030, to determine the amount of contributions of the Member States for 2025–2030 by annually increasing the contribution of each Member State by 5%. For the Arab Republic of Egypt, taking into account the approved schedule of gradual entry into payment of the contribution, this method of calculating the contribution shall be used from 2028;

— to commission the JINR Directorate and the Working Group to further improve the current methodology for calculating the contributions of the Member States for its application after 2030;

— to maintain the effect of the Rule for the lower limits of contributions until the approval of a new version of the methodology for calculating the contributions of the Member States.

Regarding the report "Draft budget of JINR for the year 2025, provisional contributions of the Member States for the years 2026, 2027, 2028," by N. Kalinin, Head of the JINR Budget and Economic Policy Department, the Finance Committee recommended the following to the Committee of Plenipotentiaries:

— to approve the JINR budget for 2025 with the income amounting to US$229 017.7 thousand and the expenditure amounting to US$276 600.3 thousand with the closing negative balance amounting to US$47 582.6 thousand;

— to authorize the Director of JINR to make adjustments to the JINR budget for 2025, including adjustments to the personnel remuneration and costs for international cooperation within the approved budget in compliance with the Regulations for the Introduction of Adjustments to the Budget of JINR;

— to approve the contributions of the JINR Member States for the year 2025 with an increase of 5% compared to 2024, with the exception of the Arab Republic of Egypt, which pays contributions to the JINR budget until 2028 based on the schedule of gradual entry into the payment of contributions;

— to approve the provisional contributions of the JINR Member States for the years 2026, 2027, 2028;

— to approve the budget for the year 2025 on the construction and exploitation of the NICA complex of superconducting rings for heavy-ion colliding beams with the special-purpose funds of the Russian Federation, provided in accordance with the Agreement between the Government of the Russian Federation and JINR, in the amount of 1 486 726.7 thousand rubles;

— to approve the consolidated adjustment of the JINR budget for the year 2024 over 9 months;

— to authorize the Director of JINR to index the salary and tariff parts of the remuneration package of the Institute's employees, taking into account the needs and possibilities of the JINR budget for 2025, in accordance with the JINR Collective Bargaining Agreement for 2023–2026;

— to emphasize the importance of finding joint solutions in the current geopolitical conditions regarding the payment of contributions by the Member States to the JINR budget.

Regarding the report "On approval of the List of JINR officials" by A. Kharevich, Head of the JINR Legal Department, the Finance Committee recommended the following to the Committee of Plenipotentiaries:

— to approve the List of JINR officials annexed to the Agreement between the Government of the Russian Federation and the Joint Institute for Nucle-

ar Research on the Location and Terms of Activity of the Joint Institute for Nuclear Research in the Russian Federation, signed in Dubna, Moscow Region, on 23 October 1995;

— to commission the JINR Directorate to conduct negotiations with the Government of the Russian Federation to agree on the approved List of JINR officials;

— to authorize the JINR Director to sign the List of JINR officials, approved and agreed with the Government of the Russian Federation, on behalf of the Joint Institute for Nuclear Research.

Regarding the report "Results of the audit of the financial activities of JINR performed for the year 2023" by D. Korsakov, Director of the "Korsakov and Partners" audit company, the Finance Committee recommended that the Committee of Plenipotentiaries approve the audit report based on the results of the audit of JINR's financial activities for the year 2023.

The Finance Committee thanked N. Kučerka, Deputy Director of the Frank Laboratory of Neutron Physics, for his interesting and informative report "Progress in the development of research on functional materials and nanosystems at the IBR-2 reactor".

The Finance Committee expressed its gratitude to the organizers and the Plenipotentiary of the Government of the Republic of Belarus to JINR for the high level of preparation and holding of the meeting of the Finance Committee.

PROGRAMME ADVISORY COMMITTEES

59th MEETING OF THE PAC FOR PARTICLE PHYSICS, 22 January 2024

The 59th meeting of the Programme Advisory Committee for Particle Physics took place on 22 January via videoconference and was chaired by Professor I. Tserruya.

The Chair of the PAC for Particle Physics, I. Tserruya, presented an overview of the implementation of the recommendations adopted at the previous meeting. JINR Vice-Director V. Kekelidze highlighted the resolution of the 134th session of the JINR Scientific Council (September 2023) relevant to the PAC for Particle Physics and the decisions of the JINR Committee of Plenipotentiaries (November 2023).

The PAC welcomed the adoption of the new Seven-Year Plan for the Development of JINR and the plans of the Institute's Directorate to concentrate efforts on the priority implementation of major projects, including the flagship megascience project NICA.

The PAC heard the progress report on implementing the Nuclotron–NICA project, presented by A. Sidorin. The Committee appreciated the successful completion of the assembly of the ISCRA and SIMBO stations for applied research. The installation of the NICA collider magnets continues in the tunnel. In particular, the elements of the RF1 and RF2 sys-

Dubna, 22 January. The 59th meeting of the Programme Advisory Committee for Particle Physics

tems were installed, vacuum annealing and vacuum tests were carried out. The power supply system for structural elements of the collider is ready for commissioning. The PAC was pleased to note the start of a personnel training programme in preparation for the collider's commissioning in 2025.

The PAC took note of the progress report on the infrastructure developments at VBLHEP, presented by N. Agapov. The Committee noted with satisfaction that full completion of the commissioning of the NICA cryogenic complex is planned for August 2024.

The PAC took note of the report on the implementation of the MPD project, presented by V. Ryabov. The production of all components of the MPD first-stage detector is progressing with minimal delays. Further progress will strongly rely on the readiness of engineering systems in the MPD building, including stable electricity and water-cooling systems, which are required to be fully operational by May 2024.

The PAC appreciated the progress in the implementation of the BM@N project, presented by M. Kapishin. The BM@N team efforts were concentrated on aligning the detectors, improving the tracking algorithm, calibrating the time-of-flight system, and correcting the pile-up in the forward detectors for centrality determination. The first processing of the reconstructed data recorded in 3.8*A* GeV Xe–CsI collisions was performed using the DIRAC system at the MLIT Tier-1/Tier-2 computers.

The PAC took note of the report on preparing the Technical Design Report of the SPD experiment, presented by A. Guskov. The cost estimate has been updated taking into consideration current prices and availability of materials and equipment. The Committee appreciated the appointment of the international SPD Detector Advisory Committee and the progress in forming the SPD collaboration. The PAC recommended that the new DAC conduct a thorough review of the updated TDR and present a report at the next PAC meeting.

The PAC supported plans for the study of η- and Δ-nuclei production in the SCAN-3 project, presented by S. Afanasiev. A TOF system was developed based on a SiPM matrix and a fast plastic scintillator, two neutron counters were assembled, the magnet spectrometer received from the Lebedev Physical Institute was modified and equipped with proper electronics, and two straw drift chambers complemented the two-coordinate proportional chamber and microstrip silicon vertex detector for the tracking system. The PAC recommended extending the SCAN-3 project for 3 years until the end of 2027 with ranking A.

The PAC heard the progress report on the implementation of the in-house ALPOM-2 project, presented by N. Piskunov. The main goal of the project is to measure the analyzing power of scattering reactions of polarized nucleons on various targets. This experiment will ensure JINR's leadership in the field of polarimetric equipment and research. The PAC recommended extending the ALPOM-2 project until the end of 2027 with ranking A.

The PAC took note of the report on the implementation of the DSS experiment on the internal target of the Nuclotron, presented by V. Ladygin. The PAC recognized significant progress in obtaining experimental data on power analysis in deuteron–proton elastic and proton–proton quasi-elastic scattering, and recommended extending the DSS project until the end of 2027 with ranking A.

The commissioning of the NICA facility in the next years, including the accelerator complex and the experiments, together with the high priority given to NICA's BM@N, MPD, and SPD flagship experiments, makes it questionable whether or not beam time will be available for other experiments. This may affect the timely realization of the SCAN-3, ALPOM-2, and DSS projects. In view of that, the PAC recommended that the VBLHEP and NICA managements define an overall strategy for the availability of beam time for users for the next 2–3 years.

The PAC heard the proposal to open a new project "Fundamental and applied physics using beams of relativistic accelerated electrons (FLAP)" presented by A. Baldin. The FLAP collaboration is planning to carry out its research at the linear electron accelerator Linac-200. The project is related to the fundamentals of electromagnetic interactions, as well as new applications. The PAC supported the proposal to develop these interlaboratory activities at JINR and recommended opening the new project, FLAP, for the period of 2024–2028 with ranking A.

The PAC heard with interest the proposal to open a new project entitled "HyperNIS–SRC: HyperNuclear Intrinsic Strangeness and Short-Range Correlations" presented by A. Averyanov. The initial stage of the experimental programme aims at studying the lightest neutron-rich hypernuclei, like ${}^{6}_{\Lambda}\mathrm{H}$, ${}^{4}_{\Lambda}\mathrm{H}$, ${}^{3}_{\Lambda}\mathrm{H}$. The PAC supported the proposed experiment with hypernuclei at the Nuclotron, the plans to expand the setup for the SRC study, and recommended approval of this project until the end of 2029 with ranking A.

The PAC took note of the reports on the scientific results obtained by the JINR groups participating in the LHC experiments, presented by E. Rogochaya (ALICE), E. Khramov (ATLAS), and V. Karjavin (CMS). The PAC noted active participation in physics analyses of the three JINR teams and their valuable contributions to the detectors upgrade for operation at high luminosity of the HL-LHC.

58th MEETING OF THE PAC FOR CONDENSED MATTER PHYSICS, 25 January 2024

The 58th meeting of the Programme Advisory Committee for Condensed Matter Physics was held on 25 January. It was chaired by Professor D. L. Nagy.

The Chair of the PAC presented an overview of the implementation of the recommendations made at the previous PAC meeting concerning the JINR research in the area of condensed matter physics. JINR Vice-Director L. Kostov informed the PAC about the resolution of the 134th session of the JINR Scientific Council (September 2023) and the decisions of the JINR CP (November 2023).

The PAC took note of the information on the status of obtaining a license to operate the IBR-2 facility and on preparatory work to replace the air heat exchangers of the second cooling circuit of the reactor, presented by E. Lychagin. The PAC appreciated plans and efforts of FLNP to restart the operation of the IBR-2 facility in 2024–2025.

The PAC took note of the report presented by M. Bulavin on the results of activities in 2023 and work plans for 2024 within the project "New advanced neutron source at JINR". The PAC recommended continuing work on the project of a new neutron source — the pulsed fast reactor NEPTUN. In particular, the PAC recommended the continuation of activities on verifying the dynamics model of pulsed reactors, on selecting the optimal configuration of the active core and optimizing the design of the reactor vessel and reactivity modulator. The PAC also welcomed the ongoing development of a list of R&Ds to create a full-scale model of the reactor reactivity modulator and appreciated the continuation of developing the concept of a system for fast changing the working substance in the chamber of the cryogenic moderator of the reactor.

The PAC took note of the report by G. Bokuchava on the current state of the Fourier stress diffractometer FSD at beamline 11A of the IBR-2 reactor. The PAC noted that the achievements of FLNP in developing the correlation diffractometry method are very useful for creating instruments at new long-pulse neutron sources, and supported the further development of high-resolution neutron correlation diffractometry.

The PAC heard with interest the scientific reports "Mechanisms of membrane protein crystallization in 'bicelles'" and "Scientific and methodical programmes of research with the Linac accelerator (JINR): FLAP collaboration", presented by T. Murugova and P. Karataev, respectively, and thanked the speakers.

The PAC took note of the new project preparation rules introduced at JINR in 2023 and recommended their application at future sessions.

Dubna, 25 January. The 58th meeting of the Programme Advisory Committee for Condensed Matter Physics. FLNP Director E. Lychagin makes a report

The PAC reviewed 17 virtual presentations made by young scientists in the field of condensed matter physics and related fields. The virtual poster presentation "Origin of high-pressure phase transition in the $Ln_2Ti_2O_7$ (Ln = La, Nd, Pr) Carpy–Galy phases" made by A. Asadov was selected as the best presentation of the meeting and recommended to be presented in the form of an oral report at the session of the JINR Scientific Council in February 2024. The PAC also noted two more virtual poster presentations of a high level: "DNA DSB formation kinetics in mature neurons of primary rat hippocampal cell culture after exposure to ionizing radiation with different physical characteristics" by T. Hramco and "Structural features of the fragment of cast iron cauldrons of Medieval Golden Horde: Neutron tomography data" by V. Smirnova.

58th MEETING OF THE PAC FOR NUCLEAR PHYSICS, 29–30 January 2024

The 58th meeting of the Programme Advisory Committee for Nuclear Physics was held on 29–30 January. It was chaired by Professor V. Nesvizhevsky.

V. Nesvizhevsky presented an overview of the implementation of the recommendations adopted at the previous meeting. JINR Vice-Director S. Dmitriev informed the PAC about the Resolution of the 134th session of the Scientific Council (September 2023) and about the decisions of the Committee of Plenipotentiaries (November 2023). JINR Chief Scientific Secretary S. Nedelko commented on the Seven-Year Plan for the Development of JINR for 2024–2030 approved by the JINR Committee of Plenipotentiaries, which includes the main themes and projects for research and development of the JINR infrastructure for this period.

The PAC members discussed plans for scientific research and development of the infrastructure of JINR laboratories in the field of nuclear physics within the themes and projects for 2024.

The PAC heard the report on the work plan under of the theme "Neutron Nuclear Physics" and its projects for 2024, presented by E. Lychagin. The scientific programme of the theme "Neutron Nuclear Physics" will be implemented within the framework of three projects: two scientific projects ("Investigations of neutron nuclear interactions and properties of the neutron" and "TANGRA"), and one scientific and technical project ("Modernization of the EG-5 accelerator and its experimental infrastructure").

Within the project "Investigations of neutron nuclear interactions and properties of the neutron", it is planned to resume measurements of angular correlations and γ-ray yields for already known *p*-wave resonances in various nuclei, and also to search for new *p*-resonances and new effects promising violation of parity and *T* invariance. The main work is expected to be carried out at the IREN resonance neutron source.

The project "TANGRA" is dedicated to solving fundamental and applied problems using the tagged neutron method. The area of interest of the project is nuclear reactions induced by neutrons with an energy of about 14 MeV.

Within the project "Modernization of the EG-5 accelerator and its experimental infrastructure", it is planned to replace the high-voltage system of the EG-5 facility, the main result of which will be an increase in the ion beam current from 2–3 μA to 100–250 μA while maintaining its energy and spatial stability.

The PAC noted the good prospects of the proposed scientific programme under the theme "Neutron Nuclear Physics" and its projects.

The PAC heard with interest the report on the plans for investigations with heavy-ion beams at FLNR for 2024, presented by S. Sidorchuk. The research programme will be implemented within two projects: "Investigation of heavy and superheavy elements" and "Light exotic nuclei at the borders of nucleon stability".

Under the project "Investigation of heavy and superheavy elements" implemented at the SHE Factory, the focus will be on continuing experiments on the synthesis of new superheavy elements with numbers 119 and 120 in the $^{54}Cr + ^{238}U$ reaction at the DC-280 accelerator complex (SHE Factory), as well as on preparing and conducting the first experiments on the spectroscopy of isotopes of superheavy elements synthesized in the $^{48}Ca + ^{242}Pu$ reaction. The experiment will be carried out using the GRAND separator and the GABRIELA-2 detection setup comprising five clover high-purity germanium γ detectors. Research at the CORSET setup will mainly focus on studying the dynamics of multinucleon transfer reactions leading to the formation of two or more than two heavy reaction products in the exit channel.

The main task of the project "Light exotic nuclei at the borders of nucleon stability" in 2024 will be the preparation and conduct of the first experiments aimed at studying the structure of light nuclei near the borders of nucleon stability at the ACCULINNA and ACCULINNA-2 fragment separators of the upgraded U-400M accelerator. Research will focus on studying the structure of heavy helium isotopes $^{6,7}He$ and the mechanisms of reactions leading to the formation of unbound exotic systems such as 4*n*.

The PAC supported the scientific and technical programmes under the theme "Synthesis and Properties of Superheavy Elements, Structure of Nuclei at the Limits of Nucleon Stability" and continued work on the projects "Research of heavy and superheavy

Dubna, 29–30 January. Presidium of the Programme Advisory Committee for Nuclear Physics

elements" and "Light exotic nuclei at the borders of nucleon stability".

The PAC heard the report on the development of FLNR's accelerator and experimental base, presented by V. Semin. In 2024, the main efforts within the project will be focused on providing beams with the required characteristics for the implementation of FLNR's experimental programme at the existing accelerator complexes DC-280 and U-400, completing the upgrade and commissioning work at the U-400M accelerator, as well as ensuring first experiments with beams of radioactive nuclei; and completing the construction of the DC-140 accelerator complex for applied heavy-ion investigations.

Under the project "Construction of the U-400R accelerator complex", the improvement of the technical parameters of the components of the upgraded U-400R accelerator, the construction of a new experimental hall, and the designing of novel setups for this experimental hall will continue.

The project "Development of the experimental setups to study the chemical and physical properties of superheavy elements" is aimed at developing the multi-reflection time-of-flight mass spectrometer and pre-separator GASSOL based on a gas-filled superconducting solenoid.

The PAC endorsed the proposed programme for the development of FLNR's accelerator and experimental base under the JINR large research infrastructure project "Development of the FLNR Accelerator Complex and Experimental Setups (DRIBs-III)".

The PAC heard with interest the review of the nuclear physics scientific programme at DLNP, presented by E. Yakushev. Areas of nuclear physics research at the Laboratory include both classical spectrometry of radioactive isotopes and the investigation of various rare phenomena by nuclear physics methods. The theme "Non-Accelerator Neutrino Physics and Astrophysics" is aimed at searching for evidence of the existence of new physics beyond the Standard Model. There are three projects in the theme: "Nuclear spectrometry for the search and investigation of rare phenomena", "Investigations of reactor neutrinos on a short baseline" and "Radiochemistry and spectroscopy for astrophysics and nuclear medicine". The projects complement each other because their implementation is linked by common approaches and resources.

The PAC members noted that a significant part of the Laboratory's manpower involved in the nuclear physics programme is assigned to the construction and commissioning of the Baikal-GVD gigaton volume neutrino telescope, which is part of the large research infrastructure of JINR.

The PAC recommended that the support of the experiments conducted within the DLNP nuclear physics scientific programme be continued, as well as emphasized the importance of efforts to further improve the experimental base at JINR.

The PAC heard two reports: "Verification of T invariance in the total interaction cross section of neutrons with unpolarized nuclei using the polarization–asymmetry theorem" presented by V. Skoy and "Study of the properties and applications of nanodiamond reflectors of low-energy neutrons" presented by A. Nezvanov. The PAC supported the continuation of these studies.

The PAC reviewed and discussed nine short presentations in the field of nuclear physics research by young scientists from FLNP. The three best short presentations selected are: "Enhanced directional extraction of very cold neutrons using a diamond nanoparticle powder reflector" presented by A. Nezvanov, "Chromium, nickel and zinc accumulation and translocation in root and leafy vegetables irrigated with industrial effluents — A laboratory study" presented by A. Kravtsova, and "Experimental setup for elemental analysis using prompt gamma rays at IBR-2 research reactor" presented by C. Hramco.

The presentation of A. Nezvanov "Enhanced directional extraction of very cold neutrons using a diamond nanoparticle powder reflector" was recommened to be reported at the session of the Scientific Council in February 2024.

59th MEETING OF THE PAC FOR NUCLEAR PHYSICS, 13–14 June 2024

The 59th meeting of the Programme Advisory Committee for Nuclear Physics was held on 13–14 June. It was chaired by Professor V. Nesvizhevsky.

The Chair of the PAC presented an overview of the implementation of the recommendations adopted at the previous meeting. JINR Vice-Director S. Dmitriev informed the PAC about the resolution of the 135th session of the JINR Scientific Council (February 2024) and the decisions of the JINR Committee of Plenipotentiaries (March 2024).

The PAC heard the report on the status of the U-400M accelerator of FLNR, presented by V. Semin. The commissioning of the U-400M accelerator and first experiments using it are planned for the second half of 2024. The PAC noted the immense work on the upgrade of the U-400M cyclotron and recommended that thorough monitoring be provided during the commissioning of all systems in order to guarantee the reliable performance of the U-400M cyclotron with design parameters.

The PAC heard the report "Synthesis and study of the decay properties of isotopes of superheavy elements Ds and Lv" presented by N. Kovrizhnykh. Experiments to synthesize isotopes ^{275,276}Ds in the ^{48}Ca + ^{232}Th reaction were continued at the SHE Factory. This reaction was studied at four beam energies above the Coulomb barrier. Moreover, one decay chain of the ^{276}Ds isotope, discovered in 2022, as well as six decay chains of the new isotope ^{275}Ds, was detected at two maximum beam energies. ^{275}Ds was first produced in a reaction with ^{48}Ca and identified through sequential α decays leading to the known nuclei ^{271}Hs, ^{267}Sg, and ^{263}Rf previously synthesized in the ^{248}Cm(^{26}Mg, 3*n*)^{271}Hs reaction. For the first time, the new isotope ^{288}Lv was synthesized in the ^{238}U + ^{54}Cr reaction and its cross section was measured to be about 70 fb. The PAC noted that the completed experiment is an important step for setting up experiments on the synthesis of elements with $Z > 118$ and recommended that work on the synthesis of the isotopes of superheavy elements and study of their decay properties be continued, in particular, using ^{54}Cr and ^{50}Ti beams.

The PAC heard the report on the results of first experiments carried out at the ACCULINNA-2 fragment separator in 2018–2020 and on the research programme for 2024 under the project "Light exotic nuclei at the boundaries of nucleon stability", presented by V. Chudoba. The report presented interesting and important data on the low-energy spectra of the unbound nuclear systems 4*n*, $^{5-7}$H, ^{7,9}He, ^{8,10}Li produced in transfer reactions. The PAC noted the important results obtained in experiments to mea-

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sure the resolution of ^{6}H and ^{7}H ground states with extremely low cross sections.

The PAC heard the proposal of a new project "Nuclear bolometer" presented by V. Trofimov. This project is part of the programme "Study of coherent elastic neutrino scattering on atoms, nuclei and electrons and measurements of neutrino electromagnetic properties using a high-intensity tritium antineutrino source" (SATURNE project, SArov TritiUm neutRiNo Experiment) being financed by the federal budget of the Russian Federation and Rosatom. The PAC supported the opinion that it is timely and important to develop novel detection systems intended for studying rare events in the range of low energies. The project "Nuclear bolometer" does not require extra financing from JINR, and the PAC recommended that the above-mentioned work be carried out as an activity within the theme "Non-Accelerator Neutrino Physics and Astrophysics".

The PAC heard the report "Status and prospects of radiochemical research at the Dzhelepov Laboratory of Nuclear Problems of JINR" presented by A. Baimukhanova. Radiochemical research carried out is implemented within the project "Radiochemistry and spectroscopy for astrophysics and nuclear medicine". The PAC highly appreciated the radiochemical research carried out at DLNP, its high-quality and high-precision results, and noted a significant contribution of this research to nuclear medicine, spectrometry and astrophysics. The PAC recommended that work on radiochemical research be continued within the framework of this project.

The PAC heard with interest the reports "The Govorun supercomputer for JINR tasks", presented by D. Podgainy, and "Radiobiological research at JINR: Applications in radiation medicine and space exploration", presented by A. Bugay.

The PAC reviewed six short presentations in the field of nuclear physics research by young scientists from DLNP, appreciating the high quality of the presented works and talks. The Committee selected three best reports: "Real-time follow-up of multimessenger alerts at the Baikal-GVD telescope" by V. Dik, "Production of trivalent radionuclides for nuclear medicine and analysis via nuclear-spectrometric methods" by E. Kurakina, and "Status of the Ricochet experiment" by D. Ponomarev. The PAC recommended the presentation "Real-time follow-up of multimessenger alerts at the Baikal-GVD telescope" to be reported at the session of the JINR Scientific Council in September 2024.

60th MEETING OF THE PAC FOR PARTICLE PHYSICS, 17 June 2024

The 60th meeting of the Programme Advisory Committee for Particle Physics took place on 17 June. It was chaired by Professor I. Tserruya.

The Chair of the PAC presented an overview of the implementation of the recommendations adopted at the previous meeting. JINR Vice-Director V. Kekelidze highlighted the resolution of the 135th session of the JINR Scientific Council (February 2024) relevant to the PAC for Particle Physics and the decisions of the JINR Committee of Plenipotentiaries (March 2024).

The PAC welcomed the plans of the Institute's Directorate to ensure full-fledged cooperation of scientists and specialists from the JINR Member States with CERN, as well as the efforts made to establish new scientific connections with Mexico, Brazil, and China.

The PAC heard the progress report on the realization of the Nuclotron–NICA project presented by A. Sidorin. The Committee appreciated the successful completion of the first stage of the NICA megascience project: the injection complex of the collider was commissioned, including the KRION-6T heavy-ion source, HILAC, Booster, Nuclotron, and beam transfer lines; the programme of fundamental and applied research was started at the fixed target facilities. The PAC congratulated the NICA team on these achievements. The launch of the experimental programme at the collider is planned for 2025 with a gradual increase in luminosity. The PAC recommended extending the Nuclotron–NICA project until the end of 2027 with ranking A.

The PAC took note of the report on implementing the MPD project, presented by V. Ryabov. The production of all components of the MPD first-stage detector is progressing with minimal delays. At the beginning of 2024, the solenoid was cooled down to 70 K. The detector should be ready to move to the beam position by July 2025 to meet the NICA accelerator schedule.

The PAC took note of the progress report on the BM@N project, presented by M. Kapishin. The BM@N team efforts are focused on calibrating the time-of-flight system and developing methods to determine centrality in the 3.8*A* GeV Xe–CsI collisions collected in 2023. The BM@N team presented the status of physics analysis of the production of Λ hyperons and K^0_S mesons, and the direct flow of protons in Xe–CsI collisions.

The PAC took note of the status of the SPD project at NICA, presented by A. Guskov. After submitting the Conceptual Design Report, the international SPD collaboration, which currently includes more than 400 scientists from more than 30 research centres, prepared the Technical Design Report for the SPD experiment. The team is now planning to start building the subsystems of the first phase.

The SPD Detector Advisory Committee conducted a thorough review of the updated SPD TDR. Chairman of the SPD DAC, Professor I. Logashenko,

presented the evaluation report of the DAC. The PAC appreciated the achievements of the SPD team in updating the physics programme of the experiment and performing numerous R&Ds for preparation of the Conceptual and Technical Design Reports of the detector. The PAC recommended extending the SPD project until the end of 2029 with ranking A.

The PAC took note of the status of the NA61/SHINE experiment at the SPS CERN, presented by A. Dmitriev. The experimental programme includes measurements in heavy-ion, neutrino, and cosmic-ray physics. Taking into account the relevance of NA61/SHINE to the NICA project and the benefit of training young researchers in the framework of the NA61/SHINE experiment, the PAC encouraged the JINR team to gradually shift its focus to the in-house flagship projects and recommended extending the participation of the JINR group in the NA61/SHINE experiment until the end of 2026 with ranking B.

The PAC took note of the report on JINR's participation in the NA62 experiment at the SPS CERN, presented by D. Madigozhin. The goal of the experiment is to measure the very rare decay $K^+ \to \pi^+ \nu\nu$ with an accuracy of about 10%, perform a number of additional studies of rare kaon decays to test the Standard Model, and refine the parameters of chiral perturbation theory. The PAC appreciated the achievements of the JINR team participating in the NA62 experiment and recommended continuing the participation in the NA62 experiment until the end of 2027 with ranking A.

The PAC took note of the results obtained by the JINR group in the STAR experiment at the RHIC (USA) collider, presented by A. Aparin. The dependence of femtoscopic parameters on the energies and centrality of nuclear collisions was studied for energies $\sqrt{s_{NN}}$ = 3.0–7.7 GeV. The PAC encouraged the JINR STAR team to gradually shift its focus to the NICA experiments and recommended extending the JINR participation in the STAR experiment until the end of 2026 with ranking B.

The PAC took note of the report on the participation of the JINR group in the COMET project at J-PARC, presented by Z. Tsamalaidze. The experiment is aimed at exploring physics beyond the Standard Model by searching for a possible charged lepton flavor violation (CLFV) through the neutrinoless process of muon-to-electron transition. The PAC noted with satisfaction the important role that the JINR group is playing in the development and construction of the main subdetector systems of the COMET facility. The PAC also appreciated the participation of representatives of the JINR group in the management structures of the COMET collaboration and recommended continuing participation of the JINR group in the COMET experiment until the end of 2029 with ranking A.

The PAC heard the proposal to open a new project, "Development of a particle registration technique in future experiments with the participation of JINR," presented by Yu. Davydov. The project is aimed at R&D for new detectors and novel methods for pro-

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cessing and analyzing experimental data, taking into account modern trends in achieving maximum energies and intensities of particle beams. The PAC recommended that a more detailed programme outlining the specific goals and objectives of the project be prepared and presented at the PAC session in one year. Consequently, the PAC recommended opening the new project for one year with ranking A.

The PAC took note of the reports on the scientific results obtained by the JINR groups participating in the LHC experiments, presented by B. Batyunya (ALICE), I. Yeletskikh (ATLAS) and V. Karjavin (CMS). The PAC noted active participation in physics analyses of the three JINR teams and their valuable contributions to the detectors upgrade for operation at high luminosity of the HL-LHC.

The winner of the competition of reports by young scientists was K. Alishina with her report "Study of the Λ-hyperons production in collisions of carbon with solid targets in the BM@N experiment".

59th MEETING OF THE PAC FOR CONDENSED MATTER PHYSICS, 24–25 June 2024

The 59th meeting of the Programme Advisory Committee for Condensed Matter Physics was held on 24–25 June. It was chaired by Professor D. L. Nagy.

The Chair of the PAC presented an overview of the implementation of the recommendations made at the previous PAC meeting related to the JINR research in the area of condensed matter physics. JINR Vice-Director L. Kostov informed the PAC about the resolution of the 135th session of the JINR Scientific Council (February 2024) and the JINR CP (March 2024) decisions.

Having taken note of the information provided by E. Lychagin about the efforts of the FLNP team to create a new neutron source, the PAC recommended continuing work on the project to develop the new neutron source and agreed with the proposal of the FLNP Directorate that, at this stage of work, activities should be focused on the following issues: (1) development of the concept of the new source; (2) development of mathematical models describing processes leading to fluctuations in pulse energy on the basis of the IBR-2 operation experience; (3) continuation of work on developing a scientific programme for the new reactor with a concept of the instrument base; (4) continuation of work on developing the concept of a system for fast changing the working material in the chamber of the cryogenic moderator of the reactor, and extending activities on determining the optimal configuration of the cryogenic moderator chamber of the new neutron source with a working substance based on hydrogen-containing materials.

The PAC took note of the information on the progress of obtaining a license to operate the IBR-2 facility and on the preparatory work to replace the air heat exchangers of the reactor's secondary cooling circuit, presented by B. Mukhametuly. The PAC appreciated and supported FLNP's plans and efforts to restart the operation of the IBR-2 nuclear research facility in 2024–2025 and resume the FLNP User Programme in 2025. The PAC also noted the need to attract a sufficient number of experts to review projects.

The PAC was informed about the status and progress of instrument modernization at the IBR-2 reactor, presented by V. Bodnarchuk, and noted that active preparations are underway at the IBR-2 spectrometers for the reactor start-up at the end of 2024. All important elements of the spectrometers are being tested and adjusted for correct operation. Two new scintillation detectors (ASTRA-M and BSD) have been installed on the IBR-2 beamlines and are ready for test measurements after the IBR-2 reactor starts its operation. At present, implementation of the BJN project and activity on the SANSARA instrument are in progress. The PAC appreciated the progress in implementing the BJN project and recommended continuing its implementation.

Having heard the report on the current state of the DN-6 diffractometer for the study of materials at ultrahigh pressures, presented by E. Lukin, the PAC noted a significant modernization of the instrument, which makes it possible to increase the incident neutron flux density and improve the quality of experimental data. Considering that the DN-6 diffractometer is one of the most advanced facilities in the world for neutron scattering studies of materials under extreme conditions, the PAC supported the further development of this diffractometer.

The PAC recommended opening the new project "High-sensitivity sensors based on molecular recognition for virus detection", presented by A. Nechaev, for its implementation in 2025–2029. An urgent task of the project is to study and optimize the structures of optical aptasensors operating on the SERS effect for highly specific detection of biological agents, with the aim of developing a test system that, in a few minutes, allows the identification of biological agents, such as viruses, bacteria, toxins and low molecular weight products of cell activity, in complex biological fluids.

The PAC was satisfied with the ongoing activities within the project "Protection against physical and chemical stresses with tardigrade proteins (TARDISS)", presented by M. Zarubin, and recommended further continuation of the project. In the Sector of Molecular Cell Genetics of DLNP, the properties, molecular structure and perspective practical applications of the radioprotective tardigrade Dsup protein (Damage suppressor) are being studied. During collaborative experiments with FLNP on determining the structure and properties of the pro-

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tein, the authors of the project showed that Dsup is an intrinsically disordered protein that forms a highly dynamic complex with DNA and is itself resistant to radiation degradation. Based on new data, in collaboration with the FLNR Centre of Applied Physics, the composite biomaterial was created, which is a track membrane functionalized with the Dsup protein for selective cell-free isolation of DNA from solutions.

The PAC heard with interest the scientific reports "Functional renormalization group approach to some problems of condensed matter physics" and "Study of phase transitions in cathode materials for sodium-ion batteries", presented by G. Kalagov and N. Samoylova, respectively.

Following the session of virtual poster presentations, the PAC selected the contribution "Pressure effect on crystal, magnetic structure and vibrational properties of van der Waals materials" by O. Lis as the best presentation and recommended it to be presented at the session of the JINR Scientific Council in September 2024. The PAC also noted two more virtual poster presentations of a high level: "Convolutional neural networks for reconstruction of three-dimensional neutron tomography models from incomplete data" by B. Bakirov and "The effect of calcium ions on the structure and morphology of lipid membranes in the presence of amyloid-beta peptide" by S. Kurakin.

JINR PRIZES

The N. Bogoliubov Prize was awarded to Á. de Rújula (CERN) and I. Todorov (INRNE BAS, Bulgaria) for their outstanding achievements in theoretical and mathematical physics and promoting international cooperation.

WINNERS OF THE JINR SCIENTIFIC AND RESEARCH WORKS COMPETITION

For Theoretical Research Papers

First Prize

"Theoretical advances in the structural characterization of complex systems: Fractals, hierarchical and multiphase materials".

Author: E. M. Anitas.

Second Prizes

"High energy hadron elastic scattering ($\sqrt{s}$ = 3.6 GeV up to $\sqrt{s}$ = 13 000 GeV)".

Author: O. Selyugin.

"New physical effects caused by the gravitational field of objects moving at the speed of light".

Authors: E. Davydov, D. Fursaev, I. Pirozhenko, V. Tainov.

For Experimental Research Papers

First Prize

"^{7}He structure from the deuteron stripping reaction".

Authors: A. Bezbakh, R. Wolski, M. Golovkov, A. Gorshkov, A. Denikin, S. Krupko.

Second Prizes

"Nucleon and cluster transfer in reactions with the ^{9}Be nucleus".

Authors: A. Azhibekov, D. Aznabayev, T. Issatayev, S. Lukyanov, V. Maslov, K. Mendibayev, M. Naumenko, Yu. Penionzhkevich, V. Samarin, T. Zholdybayev.

"Pressure-induced phase transitions in perovskite-like layered titanates".

Authors: A. Asadov, S. Kichanov, D. Kozlenko, E. Lukin, A. Mammadov, R. Mehdiyeva.

For Methodology, Research and Technology Papers

First Prize

"Development of the BM@N spectrometer at the NICA accelerator complex".

Authors: S. Bazylev, M. Kapishin, S. Khabarov, E. Kulish, A. Makankin, S. Piyadin, M. Rumyantsev, S. Sedykh, V. Yurevich, N. Zamyatin.

Second Prizes

"Development of the software complex for the implementation of a unified architecture for distributed data processing and storage at the BM@N/NICA experiment".

Authors: E. Alexandrov, I. Alexandrov, N. Balashov, A. Chebotov, I. Filozova, K. Gertsenberger, P. Klimai, A. Moshkin, I. Pelevanyuk, G. Shestakova.

"Creation of a full-cycle technological complex for the development, production and testing of Micromegas coordinate detectors".

Authors: D. Dedovich, A. Gongadze, I. Gongadze, L. Gongadze, N. Kaurtsev, N. Kovyazina, I. Lyashko, I. Minashvili, I. Potrap, T. Rudenko.

Third Prizes

"The MONUMENT experiment: Ordinary muon capture studies for the 0νββ decay".

Authors: V. Belov, K. Gusev, I. Zhitnikov, D. Zinatulina, S. Kazartsev, N. Rumyantseva, E. Shevchik, M. Shirchenko, M. Fomina.

"Creation of a hardware and software complex to study the characteristics of the cathode strip chambers of the CMS experiment at the LHC in proton–proton interactions and studying their performance under conditions of high background".

Authors: A. Golunov, N. Gorbunov, A. Kamenev, V. Karjavin, A. Lanev, V. Matveev, V. Palchik, V. Perelygin, S. Shmatov, N. Voytishin.

"Numerical methods and problem-oriented program complexes for solving some partial differential equations of physical processes and systems".

Authors: A. Gusev, O. Chuluunbaatar, J. Buša, S. Vinitsky, T. Zhanlav, B. Batgerel, V. Ulziibayar, L. Hai, P. Wen.

For Applied Research and Technology Papers

First Prize

"Deep learning methods for various problems in agriculture".

Authors: A. Uzhinskiy, G. Ososkov, A. Nechaevskiy.

Second Prizes

"Development of contrast agents for multi-energy computed tomography".

Authors: O. Medvedev, V. Rozhkov, G. Shelkov, D. Shashurin, R. Sotenskii, E. Suslova.

"Composite and hybrid functional nanomaterials based on track membranes".

Authors: A. Nechaev, P. Apel, A. Rossouw, I. Vinogradov, O. Kristavtchuk, E. Andreev, L. Kravets, V. Kukushkin, B. Gorberg, L. Petrik.

RESEARCH AND EDUCATIONAL PROGRAMMES

BOGOLIUBOV LABORATORY of THEORETICAL PHYSICS

In 2024, at the Bogoliubov Laboratory of Theoretical Physics (BLTP), studies were carried out on the following four themes: Fundamental Interactions of Fields and Particles; Theory of Nuclear Systems; Theory of Complex Systems and Advanced Materials; Modern Mathematical Physics: Gravity, Supersymmetry and Strings. An important component of the BLTP activities is theoretical support of experimental research to be carried out within major international projects with the participation of JINR and Dubna-based experimental programmes of JINR Laboratories. The research resulted in about 430 publications in peer-reviewed journals and proceedings of international conferences, 98 articles of large international collaborations with the participation of BLTP researchers, and two monographs. Most of the results were obtained in cooperation with scientists from the JINR Member States, Brazil, China, Germany, India, Italy, South Africa, and other countries.

Every year BLTP is a venue for scientific events of the highest level: eight conferences and workshops and three schools for students and young scientists were organized by BLTP in 2024. These events were held in person or in a mixed format (in person/remote). Among the organized conferences, it is worth highlighting two major events: the Scientific Session of the Nuclear Physics Section of the Physical Sciences Division of RAS "Physics of Fundamental Interactions" and the 74th International Conference on Nuclear Physics "Nucleus-2024: Fundamental Problems and Applications". BLTP researchers and visitors made 94 reports at the thematic scientific Laboratory seminars.

International collaboration was supported by grants of the Plenipotentiaries of the Governments of Belarus, Bulgaria, Egypt, Kazakhstan, Poland, Vietnam, and the JINR Directorate, by joint programmes with Serbia and South Africa. The Bogoliubov Laboratory has collaboration agreements with APCTP (South Korea) and ITP CAS (Beijing) as well as cooperation with theorists from CERN. Seven research projects were supported by the RSF grants.

Traditionally, much attention was paid to recruiting young researchers, students, and postgraduate students to BLTP within the research and education project "Dubna International Advanced School of Theoretical Physics" (DIAS-TH). The Laboratory plays

Dubna, 1–5 April. Scientific Session of the Nuclear Physics Section of the Physical Sciences Division of RAS, dedicated to the 300th anniversary of the Russian Academy of Sciences

Beijing (China), 11 November. A cooperation agreement was signed between the Institute of Theoretical Physics of the Chinese Academy of Sciences and the Bogoliubov Laboratory of Theoretical Physics of JINR

the role of the training centre for young scientists and students from many countries. Currently, about one third of the BLTP scientific staff are young scientists and PhD students. In 2024, five candidate and three doctoral theses were defended by BLTP researchers.

SCIENTIFIC RESEARCH

Fundamental Interactions of Fields and Particles

Theoretical investigations in 2024 were carried out in the framework of the following projects:

- Quantum field theory and physics beyond the Standard Model;
- QCD and spin/3D hadron structure;
- Strong interaction phenomenology and precision physics;
- Theory of hadronic matter under extreme conditions;
- Theory of electroweak interactions and neutrino physics.

For the first time, exact results were obtained for the three-loop photon spectral density in QED with N fermion species. The expressions were given in terms of iterated integrals, which can be reduced either to multiple Goncharov polylogarithms or to one-fold integrals from the products of harmonic polylogarithms and complete elliptic integrals. The results for the near threshold ($q^2 = 4m^2$, $q^2 = 16m^2$) and high energy asymptotics of spectral density were also provided. It was shown that using the latter, it is easy to get a very accurate representation of the spectral density in the whole range of q^2 values [1].

Heavy-quark contributions to the polarized Bjorken sum rule were considered. Good agreement was found between the experimental data and the predictions of analytical QCD. To satisfy the limit of photoproduction, a new representation of the perturbative part of the polarized Bjorken sum rule, proposed recently, was used [2].

For the first time, analytical expressions were obtained for the fifth-order electromagnetic corrections in the fine structure constant α (tenth order in QED charge) to the anomalous magnetic moment of leptons a_L ($L = e, \mu, \tau$) from diagrams with insertions of the vacuum polarization operator of four lepton loops: a) all identical leptons (l), different from the original (L); b) two loops are formed by the L-type lepton, and the other two loops — by the lepton l; c) one of the loops is formed by the L-type lepton, and the other three by leptons of the l-type; d) three of the loops are formed by the L-type lepton, and one of the loops — by leptons of the l-type. The developed approach is based on consistent application of dispersion relations for the vacuum polarization operators and the Mellin–Barnes integral transform for a massive photon propagator [3].

In different models of inflationary cosmology, quantum corrections to the effective potential were computed. It was shown that the corrections lead to a modification of the initial potential uplifting its value at the minimum, which can be interpreted as a cosmological constant/dark energy. The investigation was concentrated on the models of alpha-attractors and it was shown that one can naturally get small values of the cosmological constant. In the model of quintessence, the same mechanism modifies the value of dark energy at the present time [4].

The leptonic decay widths of heavy quarkonia are complementary observables to the semileptonic decays of heavy mesons and provide additional insight into the possible lepton flavor universality breaking. The former were analyzed within the framework of the covariant confined quark model, introducing a novel approach to the description of radially excited quarkonia states, which is based on the constituent quark mass running and the orthogonality of the states. It appeared possible to describe the experimental observations by our approach within the Standard Model, which does not support new physics explanations [5].

The form factors were calculated describing the $B_s \to y*$ transition induced by the vector and tensor weak currents in a broad range of momentum transfers via the distribution amplitudes of the B_s meson. Using the available predictions for these form factors from approaches not referring to the B_s-meson distribution amplitudes, an important phenomenological parameter was extracted, the inverse moment of the B_s-meson distribution amplitude, $\lambda_{B_s}(\mu \simeq \text{mb}) =$ $= (0.62 \pm 0.10)$ GeV [6].

A class of models with the common origin of light neutrino masses, the baryon asymmetry of the Universe via leptogenesis and viable dark matter candidates was found. Due to the model symmetries, the Majorana masses of the active neutrino are generated by the inverse seesaw mechanism with the lepton number violating right-handed Majorana neutrino masses arising at three loops. The latter is ensured by the preserved residual discrete symmetries, which also guarantee the stability of the dark matter candidate. The smallness of neutrino masses is provided by the loop suppression, which allows the Yukawa coupling to be $O(1)$, thus offering rich phenomenology. In particular, charged-lepton flavor violating decays $\mu \to e\gamma$, $\mu \to eee$ and the electron–muon conversion get sizable rates within the reach of future experiments [7].

The spin oscillations of neutrinos scattered by a rotating (Kerr) black hole surrounded by a thick magnetized accretion disk were studied. Both the toroidal and poloidal magnetic fields inside the disk were considered. The precession of the neutrino spin is caused by interactions of its magnetic moment with these fields. The processing of spin oscillations of the neutrino fluxes was based on numerical modeling of the propagation of a large number of incoming test neutrinos using high-performance parallel computing at the Govorun supercomputer. Possible applications of the modelling to experiments on the detection of astrophysical neutrinos and the possibility of investigating the magnetic field distributions near black holes were discussed [8].

The prevalence of the production of twisted (vortex) particles in noncentral heavy-ion collisions was shown. In such collisions, photons emitted due to the rotation of charges are highly twisted. Charged particles are produced in nonspreading multiwave states and have significant orbital angular momenta. It can be expected that the emission of any twisted particles manifesting themselves in specific effects is rather ubiquitous. Particles emitted in strong interactions are twisted if initial interacting partons are in twisted states and are untwisted in the opposite case. The vorticity of nuclear matter plays an important role for the production of twisted particles [9].

T-odd and *T*-even hadronic structure functions were calculated for the Drell–Yan process within the framework of perturbative QCD in the collinear approximation. A decomposition for the small Q_T/Q limit of the structure functions was derived. Numerical analyses of the angular coefficients were performed and compared with the ATLAS experimental data [10].

It was shown for the first time that the values of the quark mass ratios $x = m_u/m_d$ and $y = m_s/m_d$ belong to the third-order algebraic curve $f(x, y) = 0$. Two parameters of the curve are fractional linear functions of the squared masses of π and K mesons and, when Dashen's theorem is satisfied, coincide with the values $x_w = 0.56$ and $y_w = 20.18$ obtained by Weinberg from the current algebra. It was shown that the curve is stable, i.e., it does not change when taking into account chiral corrections in the mass formulas of pseudoscalars and is universal: any two independent fractional linear functions lead to the same curve. Part of the curve corresponding to the physical values of the quark masses can be distinguished if one uses the ratio $m_s/m_{ud} = 27.23(10)$ known from calculations on the lattice, which gives $m_u/m_d = 0.455(8)$, $m_s/m_d = 19.81(10)$. The value of the low-energy constant $B_0(2\text{ GeV}) = 2.682(36)(39)$ GeV (also known from lattice simulations) allows one to obtain absolute values of the light quark masses: $m_u = 2.14(7)$ MeV, $m_d = 4.70(12)$ MeV, $m_s = 93.13(2.25)$ MeV (all values refer to the MS-bar scheme at the 2-GeV scale) [11].

Analytic expressions for initial state radiative corrections to electron–positron annihilation into virtual Z boson/photon were obtained. Some results available in the literature were corrected. The dependence on the choice of the factorization scale was investigated and its value was chosen, which allows improving the convergence of the perturbation theory series in powers of a large logarithm [12].

Analytic expressions for higher-order radiative corrections to the electron energy spectrum in the decay of a polarized muon were obtained. Some results available in the literature were corrected. The dependence of the corrections on the choice of the factorization scale was studied [13].

Using first-principle lattice simulations, a new spatially inhomogeneous phase in rigidly rotating $N_c = 3$ gluon plasma was found. This mixed phase simultaneously possesses both confining and deconfining phases in thermal equilibrium. Unexpectedly, the local critical temperature of the phase transition at the rotation axis does not depend on the angular frequency within a few-percent accuracy. Even more surprisingly, an analytic continuation of results to the domain of real angular frequencies indicates that the Tolman–Ehrenfest law does not provide an

1 July. At the opening of the 74th International Conference
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exhaustive description of the system in the vicinity of the phase transition, with the confining (deconfining) phase appearing far from (near) the rotation axis [14].

The earlier established duality between the transport coefficients in accelerated and rotating medium and gravitational anomaly was generalized for the case of nonzero cosmological constant. This opens, in principle, a possibility to explore cosmological constant manifestations by studying anomalous transport (kinematical vortical effect) in heavy-ion collisions [15].

Using a collection of 162 purely nucleonic, hyperonic, and quarkish equations of state from the CompOSE database and some other works, it was verified that hyperons lead to a significant difference in radii of stars of 1.4 and 2.0 solar masses, which diminishes in the presence of quarks. A comparison of the shapes of the mass-radius curves was made and it was shown that hyperons and quarks in the neutron star cores prefer a particular curve shape with backbending that is controlled by the density dependence of the nuclear symmetry energy. Attention was drawn to the existence of a class of purely hadronic relativistic mean-field equations of state with scalar-field dependent hadron masses and couplings that satisfy the known constraints on the equations of state including the analyses of the new NICER data and the requirement of insignificant variation of the neutron star radii [16].

The results of simulations of the directed flow of various hadrons in Au + Au collisions at collision energies of $\sqrt{s_{NN}}$ = 3 and 4.5 GeV were presented. Simulations were performed within the three-fluid dynamics model and the event simulator based on it (THESEUS). The results were compared with the recent STAR data. The directed flows of various particles provide information on the dynamics in various parts and at various stages of the colliding system depending on the particle. However, the information on the equation of state is not always directly accessible because of strong influence of the afterburner stage or insufficient equilibration of the matter. It was found that the crossover scenario gives the best overall description of the data. This crossover equation of state is soft in the hadronic phase. The transition into QGP in Au + Au collisions occurs at collision energies between 3 and 4.5 GeV, at baryon densities $n_B \gtrsim 4n_0$ and temperatures ≈ 150 MeV. In-medium effects in the directed flow of (anti)kaons were discussed [17].

Theory of Nuclear Systems

In 2024, investigations were carried out in accordance with four projects:

- Microscopic models for exotic nuclei and nuclear astrophysics;
- Low-energy nuclear dynamics and properties of nuclear systems;
- Quantum few-body systems;
- Relativistic nuclear dynamics and nonlinear quantum processes.

Using experimental data from (e, e'), (p, p') and (γ, γ') reactions, the existence of low-energy $E1$ toroidal states in ^{58}Ni was predicted. The (e, e') data were thoroughly analyzed within the self-consistent random phase approximation with Skyrme forces. It was shown that (e, e') transversal form factors can be used for indication of toroidal excitations [18].

The correlation between the spin-orbit strength and effective mass was demonstrated for various Skyrme energy density functionals without tensor force. This correlation can be used to reduce the number of parameters in these functionals. It was shown that the use of the obtained relation between the spin-orbit strength and the effective mass in the calculations of binding energies, spin-orbit splitting, and charge radii does not spoil the description of experimental data [19].

The scissors mode was investigated in the actinide region, including even–even superheavy nuclei up to ^{256}No, within the Wigner Function Moments method. Calculations allow one to conclude that the observed double-humped structure of the scissors spectrum in the lightest actinides occurs due to the energy separation of excitations of conventional scissors and spin scissors. The energy centroids and integrated $M1$ strengths for the transuranium nuclides up to ^{256}No were predicted. The results of calculations for ^{232}Th, ^{238}U, and ^{254}No are in agreement with the available experimental data [20].

A simple semianalytical collective model that takes into account the limitations of the interval of variation of the collective variable was suggested to describe the chiral dynamics in triaxial odd–odd nuclei with a fixed particle-hole configuration. The collective Hamiltonian was constructed with the potential energy obtained using the postulated ansatz for the wave function symmetric with respect to chiral transformation. By diagonalizing the collective Hamiltonian, the wave functions of the lowest states were obtained and the evolution of the energy splitting of the chiral doublets in transition from chiral vibration to the chiral rotation regime was demonstrated [21].

Approximating the angular momentum dependence of the reaction probability at a given bombarding energy by shifting it by the centrifugal energy and using the analytical formula for the elastic scattering probability, new analytical formulas for heavy-ion reaction cross section and the universal reaction function were derived. It was found that these new formulas describe the experimental data quite well and can be used for the analysis and predictions of heavy-ion reaction cross sections [22].

Spontaneous fission and α decay from K-isomeric states were studied within the dinuclear system model. All these processes were considered as evolution of a nucleus in the charge (mass) asymmetry coordinate. For even–even, even–odd actinides and superheavy nuclei, the spontaneous fission and α-decay half-lives of K-isomeric states were

calculated and compared with the available experimental data. The origin of the hindrance of spontaneous fission from the high-*K*-isomeric states was explained [23].

The observed cross section of the synthesis of the heavy isotopes of the superheavy element darmstadtium in hot fusion reaction ^{48}Ca + ^{232}Th was much smaller than the one in the cold fusion reaction ^{64}Ni + ^{208}Pb. Fusion of nuclei in the hot fusion reaction ^{48}Ca + ^{232}Th was considered as evolution of the dinuclear system to a stable compound nucleus of the isotope ^{280}Ds. The quasifission is one of the reasons causing smallness of the yield of the evaporation residues products. Another reason of this phenomenon is the decrease of the fission barrier for the isotopes $^{275–285}$Ds related with the shell effects in the neutron structure [24].

The model was developed for the dynamical description of nuclear fission processes in the region of heavy nuclei based on the dinuclear systems (DNS) approach. After crossing the fission barrier, a fissile nucleus was treated as a superposition of DNS. The distribution of primary fission fragments was described as a result of competition between evolution of initially formed DNS and its decay in relative distance. The level densities required for calculations were microscopically derived accounting for deformation and excitation energy effects. The calculations performed for even $^{244–260}$Fm isotopes give a good description of mass and neutron multiplicity distributions. To describe sudden onset of symmetric fission in ^{258}Fm, the fissile nucleus was treated as a superposition of DNS at smaller elongations than for lighter Fm isotopes, which is in line with significant reduction of half-life for ^{258}Fm. The results indicate the presence of bimodality due to the coexistence of spherical and deformed mass symmetric fission modes [25].

A reliable way of calculating the width Γ of an extremely narrow quantum resonance was suggested. The proposed method is based on expanding the Jost function in the Taylor series around the real resonance energy E_r and looking for its zero at the nearby complex point $E_r - i\Gamma/2$. The coefficients of such expansion can be obtained by solving a set of coupled differential equations. Using two simple exactly solvable models, it was demonstrated that the method is efficient and accurate [26].

A numerical scheme based on the use of the parabolic wave packets (PWP) was presented for solving the time-dependent Schrödinger equation. As the simplest quantum system for investigating the method, a hydrogen atom in a laser EM field was considered [27].

Canal (discrete, 2D-localized) states embedded in the continuum were studied for a particle interacting with thin 3D layer of 2D-periodic zero-range potentials. General analysis was presented for a "molecular monolayer" obtained by 2D periodic mapping of *N* different zero-range scatterers. Numerical calculations of canal states were performed for the case of an atomic bilayer on a square lattice. For particle scattering on this system, the manifestations of canal states in impact-energy and impact-angle dependence of total reflection/transmission probabilities were demonstrated. Special cases when energy eigenvalues of the canal states tend to scattering thresholds were also analyzed [28].

The quantum mechanical four-particle Faddeev–Yakubovsky equation was generalized to the relativistic case. The resulting equation was applied to study the ^{4}He nucleus. Using the rank-one separable potential of nucleon–nucleon interaction, the binding energy of the nucleus was calculated. The calculation result differs significantly from the nonrelativistic one [29].

A new relativistic expression was presented for the Sommerfeld–Gamow–Sakharov factor (*S*-factor) of a composite system of two spin-1/2 particles of arbitrary masses interacting via a Coulomb-like chromodynamical potential. The analysis was performed within the framework of a relativistic quasipotential approach based on the Hamiltonian formulation of the covariant quantum field theory in the relativistic configuration representation suggested by A. Logunov, A. Tavkhelidze, and V. Kadyshevsky. The pseudoscalar, vector and pseudovector systems were considered and the behaviour of the *S*-factor near the threshold and in the relativistic limit was investigated in detail. It was argued that at the threshold, the contribution of spins significantly reduces the Sommerfeld effect, while at ultrarelativistic velocities, their role diminishes and the *S*-factor becomes basically the same as for the spinless systems [30].

A theoretical analysis of the reactions of hard knockout of a proton by a proton from a carbon nucleus ^{12}C(p, $2pn_s$)^{10}B and ^{12}C(p, $2pp_s$)^{10}Be was carried out in inverse kinematics at an incident nucleus momentum of 48 GeV/*c*, which were recently studied by the BM@N Collaboration. Here n_s and p_s denote a slow nucleon in the ^{12}C rest frame included in a short-range correlated *NN* pair. The spectroscopic amplitude of the *NN*–*B* system, where *B* is the residual nucleus, was calculated within the framework of the TISM. The interaction of the target proton with the *NN* pair of the projectile nucleus was considered in the distorted-wave impulse approximation. Herewith, the effects of strong absorption and single charge exchange due to interactions in the initial and final states were taken into account in the eikonal approximation. A good description of the shape of the experimental distributions of relative angles and momenta of particles in the ^{12}C rest frame was obtained, and predictions were made for the absolute value of the corresponding differential cross sections [31].

The thermodynamic properties of the system produced in ultrarelativistic heavy-ion collisions were studied. The parameters were obtained from the transverse momentum distributions of final particles based on several theoretical models. The well-known hydrodynamic Blast-Wave approach based on Boltzmann statistics was used. Further, a new

approach based on q-dual statistics was applied, which can provide more information about the system, particularly its chemical potential, and measure the difference between the produced system from the classical equilibrium. It was observed that the kinetic freeze-out parameters depend on collision centrality and energy. The results obtained for the Blast-Wave model are in agreement with the previously published results. For q-dual statistics, it was seen that in peripheral collisions the system is less equilibrated, which leads to an increased deviation from the classical distribution [32].

For the first time, the developed theory of nonlinear multiphoton quantum processes in strong electromagnetic fields was used for evaluation of the polarization properties of recoil Compton photons in interaction of ultrarelativistic electrons with intense laser pulses in a wide range of electron energies and laser beam intensities [33].

Theory of Complex Systems and Advanced Materials

Theoretical investigations in 2024 were carried out within the framework of the following projects:

- Complex materials;
- Nanostructures and nanomaterials;
- Mathematical models of statistical physics of complex systems;
- Methods of quantum field theory in complex systems.

The correlation properties of a random system of densely packed disks, obeying a power-law size distribution, were analyzed in reciprocal space in the thermodynamic limit. This limit assumes that the total number of disks increases infinitely, while the mean density of the disk centres and the range of the size distribution are kept constant. The structure factor dependence on momentum transfer across various numbers of disks was investigated and these findings were extrapolated to the thermodynamic limit. The fractal power-law decay of the structure factor is recovered in reciprocal space within the fractal range, which corresponds to the range of the size distribution in real space. The fractal exponent coincides with the exponent of the power-law size distribution. The dependence of the structure factor on density was examined. It was found that the power-law exponent remains unchanged but the fractal range shrinks when the packing fraction decreases [34].

The confinement-induced resonances for trapped bosons in the cigar-shaped and pancake geometries were studied within the generalized Gross–Pitaevskii equations, which are a simplified version of the Hartree–Fock–Bogoliubov approximation. Although the Hartree–Fock–Bogoliubov method is considered applicable only for small interparticle interactions, the resonance denominators for the chemical potential were obtained in both quasi-one and quasi-two dimensions. A useful integral representation of the one-particle Green function was found for the cylindrical confinement. The position of a smoothed resonance was found for the chemical potential in the pancake geometry at positive scattering length [35].

A combination of experimental and numerical methods was used to study magnetic properties of $SrCoGe_2O_6$, a member of a pyroxene family with magnetic cobalt ions. Recently, materials with edge-sharing ligand octahedra around mangnetic Co^{2+} ions were proposed to host strong Kitaev interactions which can induce magnetic frustration and subsequent enhancement of quantum effects. Inelastic neutron scattering was used to extract magnetic exchanges and show that Kitaev interaction is of the same order as the isotropic Heisenberg one. *Ab initio* DFT calculations support this result [36].

A method was described for the extrapolation of perturbative expansions in powers of asymptotically small coupling parameters or other variables onto the region of finite variables and even to the variables tending to infinity. The method involves the combination of ideas from renormalization group theory, approximation theory, dynamical theory, and optimal control theory. The extrapolation was realized by means of self-similar factor approximants, whose control parameters can be uniquely defined. The method allows one to find the large-variable behavior of sought functions knowing only their small-variable expansions. The strong-coupling behavior of Gell-Mann–Low functions in multicomponent field theory, quantum electrodynamics, and quantum chromodynamics was found based on their weak-coupling perturbative expansions [37].

In the effort to study the radiation resistance of materials under the gamma radiation, numerical studies of zirconium diboride (ZrB_2), tungsten carbide, and tungsten crystals (WC, W) were performed. Specifically, the defect formation and migration as analyzed by means of positron annihilaton spectroscopy was numerically investigated [38].

The exact densities of loops in the $O(1)$ dense loop model in a square lattice wrapped on a cylinder of odd circumference were obtained. They are equal to the densities of critical bond percolation clusters on a 45° rotated square lattice rolled into a cylinder with special boundary conditions referred to as a half-turn self-dual percolation [39].

The totally asymmetric simple exclusion process (TASEP) with generalized update is a version of the discrete time TASEP with an additional interparticle interaction that controls the degree of particle clustering. Though the model was shown to be integrable on the ring and on the infinite lattice, on the open chain it was studied mainly numerically, while no analytic results existed even for its phase diagram. New boundary conditions associated with the infinite translation invariant stationary states of the model were introduced, which allow one to obtain the exact phase diagram analytically. The phase diagram was described in detail and the analytic predictions were confirmed by extensive numerical simulations [40].

The ground-state entanglement properties in the 1D antiferromagnetic spin-1 Heisenberg model with the external magnetic field B and single-ion anisotropy D were investigated. The logarithmic negativity for nearest and non-nearest neighbor sites on finite chains was obtained. The resulting phase diagram was discussed in the B–D plane, and a line where the energy density is independent of the size was determined and shown to end at a triple point. Finally, the results for the logarithmic negativity on finite chains at finite temperature as a function of B and D were presented [41].

The origin of the superconformal indices, which played a key role in the group-theoretical interpretation of the elliptic hypergeometric integrals, was investigated. A direct connection was discovered with old works on the modified supersymmetric quantum mechanics built either by a replacement of the fermion by a parafermion of the second order, or by a transition to a nonlinear deformation of supersymmetry algebra. These models are directly related to the weak supersymmetry of A. Smilga with the supersymmetry algebra $su(2|1)$. A complete classification of possible values of this index in the models with weak supersymmetry was given — there are five types of them. It was shown that in all cases, the Witten index for systems with the algebra quadratic in the Hamiltonian obeying some unusual properties is equivalent to the superconformal index [42].

The topological superconductivity with Majorana zero modes is of fundamental scientific importance due to its proposed application in braiding-based quantum computing. Specifically, a system consisting of a one-dimensional chain of strongly correlated fermions placed on a superconducting substrate was proposed. Strong electron correlation was shown to drive an extended s-wave superconductor into a topological superconductor that hosts Majorana fermions. In contrast to the approaches based on mean-field treatments, no Zeeman or exchange magnetic field was needed to produce such an effect. Possible ways were proposed to experimentally realize the considered system [43].

The unique resonance and locking phenomena in the superconductor–erromagnet–superconductor φ_0 Josephson junction under external electromagnetic radiation were demonstrated when not just the electric but also the magnetic component of external radiation is taken into account. Due to the coupling of superconductivity and magnetism in this system, the magnetic moment precession of the ferromagnetic layer caused by the magnetic component of external radiation can lock the Josephson oscillations, which results in the appearance of a particular type of steps in the current-voltage characteristics completely different from the well-known Shapiro steps. These steps may be called the Buzdin steps in the case when the system is driven only by the magnetic component and the Chimera steps in the case when both magnetic and electric components are present. Unlike the Shapiro steps where the magnetic moment remains constant along the step, here it changes though the system is locked. The spin-orbit coupling substantially contributes to the amplitude, i.e., the size of these steps. Dramatic changes in their amplitudes are also observed at frequencies near the ferromagnetic resonance. Combinations of the Josephson and Kittel ferromagnetic

15–19 July. The 2nd International Conference “Modern Problems of Condensed Matter Theory”

resonances together with different types of locking pronounced in the dynamics and current-voltage characteristics make the physics of this system very interesting and open up a series of new applications [44].

A field-theoretic model of magnetic hydrodynamics with broken spatial parity in the regime of developed turbulence was investigated, and all renormalization constants in the two-loop approximation that determine the behavior of magnetic spectra of the system in the regime of developed turbulence were calculated. As a result of calculations, it was found that in a system without broken parity, the spectrum of magnetic energies behaves almost like k^{-2}. This may indicate in favor of the fact that the phenomenological theory that can describe this type of systems is the so-called Goldreich–Sridhar theory. Further analysis of these systems was carried out in the phase with spontaneously broken symmetry, which corresponds to the dynamo regime, i.e., the appearance of a nonzero uniform magnetic field in the system that stabilizes it [45].

The fourth order of ε expansion in the model of infinite-dimensional turbulence was calculated by the renormgroup method using the hyperlogarithm method [46].

The most general form of dynamic stochastic equations was proposed to describe the critical dynamics in the critical region of the superconducting phase transition [47].

Modern Mathematical Physics: Gravity, Supersymmetry and Strings

The topics of main focus in the theme in 2024 were:

- Quantum groups and integrable systems;
- Supersymmetry;
- Quantum gravity, cosmology and strings.

Finite-temperature holographic RG flows in $D = 3$, $N = (2,0)$ gauged truncated supergravity coupled to a sigma model with a hyperbolic target space were considered. In the context of the holographic duality, fixed points (CFTs) at finite temperature are described by anti-de Sitter (AdS) black holes. A transition was made from the gravity equations of motion to a 3D autonomous dynamical system, whose critical points can be related to fixed points of dual field theories. Near-horizon black hole solutions correspond to infinite points of this system. Poincaré transformations were used to project the system on R^3 into the 3D unit cylinder such that the infinite points are mapped onto the boundary of the cylinder. The space of solutions was explored numerically. It was shown that the exact RG flow at zero temperature is the separatrix for asymptotically AdS black hole solutions if the potential has one extremum, while for the potential with three extrema, the separatrices are RG flows between AdS fixed points. Near-horizon analytical solutions were found for asymptotically AdS black holes using the dynamical equations. Also, the method was presented for constructing full analytical solutions [48].

Lagrangian geometry of Grassmann variety $\mathrm{Gr}(1, n)$ was studied: examples of Lagrangian submanifolds of the Mironov type were constructed for any degree of homogeneity $k = 0, \ldots, n$. Moreover, constructing the Mironov cycles, another way of construction was found, which increased the row of new topological types of smooth Lagrangian submanifolds in Grassmannian $\mathrm{Gr}(1, n)$ by one and a half times. Before these papers appeared there was only one universal example presented almost 50 years ago by I. Gelfand, namely, the Lagrangian torus [49].

A new model of an infinite spin particle in curve space was presented. The model is described by additional commuting Weyl spinor coordinates. It was proved that such a model is consistent only in external gravitational field corresponding to the constant curvature spaces. The Lagrangian and gauge transformations for free bosonic infinite spin field theory in AdS_4 space were derived. It was shown that in the model under consideration, infinite spin fields in AdS_4 space are described by the most degenerate representations of the $SO(2,3)$ group [50].

An off-shell $N = 2$ superconformal cubic vertex was constructed for the hypermultiplet coupled to an arbitrary integer higher spin gauge $N = 2$ supermultiplet in a general $N = 2$ conformal supergravity background. $N = 2$, 4D unconstrained analytic superconformal gauge potentials were derived for an arbitrary integer spin. Using the harmonic superspace approach, supersymmetric curvatures were constructed at the linearized level $N = 2$ generalizing the scalar curvature, the Ricci curvature, and the Weyl tensor. The $N = 2$ super-Weyl tensor was generalized to higher spins and then used to construct conserved higher spin $N = 2$ supercurrents [51].

It was shown that for gauged scalar fields minimally coupled to Einstein–Maxwell theory, the Mayo–Bekenstein no-hair theorem can be circumvented when including appropriate scalar self-interactions, allowing static electrically charged black holes to be endowed with (Abelian) gauged scalar hair. Here it is shown that these spherically symmetric solutions can be extended to include a magnetic charge in a model with scalar multiplets. The resulting dyonic configurations share most of the properties of the electrically charged solutions, in particular, satisfying the same resonance condition, with the existence of a mass gap with respect to the bald Reissner–Nordström dyonic black holes. A distinctive feature, however, is that no solitonic limit exists for a nonzero magnetic charge [52].

Gravitational shockwaves are geometries where components of the transverse curvature have abrupt behavior across null hypersurfaces, which are fronts of the waves. In order to describe the effect of a gravitational shockwave on field systems, a general approach was developed, which is applicable to fields of different spins. The perturbations caused by a shockwave were found as solutions to characteristic Cauchy problem with the initial data

on the wave front determined by a supertranslation of ingoing fields. New physical effects were predicted, such as radiation of electromagnetic and gravitational waves due to the interaction of point charges or masses with a gravitational shockwave, the occurrence of secondary shockwaves in the field systems themselves, and a number of other effects. The approach is applicable to gravitational shockwaves of a general class including geometries sourced by null particles and null branes [53].

Null cosmic strings were shown to disturb gravitational fields of massive bodies and create outgoing gravitational waves (GW). The space–time created by the source and the string is shown to have an asymptotically polyhomogeneous form. The GW flux was calculated in such space–times, and it was demonstrated that the averaged intensity of the radiation is maximal in the direction of the string motion. Opportunities to detect null string generated gravity waves were analyzed [54].

Null cosmic strings disturb electromagnetic (EM) fields of charged sources and sources with magnetic moments and create EM waves outgoing from the sources. For magnetic-dipole-like sources, the radiation flux depends on the orientation of the magnetic moment with respect to the string. Estimates were made that showed that the peak power of the radiation can be quite large for null strings moving near pulsars and considerably large in the case of magnetars. The string generated variations of the luminosities of the stars can be used as a potential experimental signature of null cosmic strings [55].

The dynamics of a scalar field was considered in compactification scenario of Einstein–Gauss–Bonnet cosmology. It was shown that if the field is nonminimally coupled to curvature, its asymptotic value under certain conditions can be shifted from the minimum of its potential. This means that due to influence of extra dimensions, a scalar field with fourth-order potential can stabilize away from the zero-field stable point indicating effective symmetry breaking in such a system [56].

Using the split Casimir operators, the decomposition of the antisymmetric part of ad^5 was found. This decomposition contains the representations that appeared in the decomposition of ad^4 and only one new representation X5. The dimension of this representation was proposed earlier in the paper by A. J. Macfarlane and H. Pfeiffer (J. Phys. A: Math. Gen. 2003. V. 36. P. 2305). The decomposition is valid for all Lie algebras [57].

A Hamiltonian formulation of the new model of $N = 8$ supersymmetric mechanics recently proposed by S. Fedoruk and E. Ivanov was given and it was shown that it possesses the dynamical $N = 8$ superconformal symmetry $osp(8|2)$. The bosonic part of the Hamiltonian is just a free particle on the eight-dimensional cone embedded in nine-dimensional pseudo-Euclidean space, while the fermionic part can be interpreted as a spin-orbit interaction term [58].

DUBNA INTERNATIONAL ADVANCED SCHOOL OF THEORETICAL PHYSICS (DIAS-TH)

Within the framework of the DIAS-TH educational programme, three schools for students and young scientists were organized in 2024.

The DIAS-TH Winter School “Many-Particle Systems: From Condensed Matter to Quarks and Stars” was held from 29 January to 3 February. Its main topics were: theoretical description of interacting fermion systems, cold fermion gases, vacuum instabilities and phase transitions, properties of the QCD matter, problem of the quark–gluon confinement, properties of compact stars. The participants were mostly young theorists, 53 Master’s and PhD

29 January – 3 February. The 18th International Winter School “Many-Particle Systems: From Condensed Matter to Quarks and Stars”

students and young postdocs representing Moscow State University, MEPhI, MIPT, Ioffe Physical-Technical Institute, HSE, Saint Petersburg State University, and JINR. A group of students from Bogazici University (Istanbul, Turkey) also took part in the School.

The School "Nuclear Theory and Astrophysical Applications" was held on 11–17 February. The following topics were discussed: nuclear structure studies, fusion and multinucleon transfer reactions, nuclear reactions of astrophysical interest, novel approaches to nuclear fission, neutrino interactions with nuclei/nuclear matter and supernovae, cluster approaches to features in nuclei. The School was attended by 78 students, postgraduates and young scientists from Belgorod, Dubna, Irkutsk, Kazan, Khabarovsk, Moscow, Novosibirsk, Omsk, Saint Petersburg, Saratov, Sarov, Tomsk, Vladivostok, Voronezh, and Yakutsk.

The traditional International Summer School DIAS-TH "Advanced Methods of Modern Theoretical Physics: Integrable and Stochastic Systems" (21–26 July) presented lecture courses on field-theoretical, functional and statistical methods that are used in the study of nonequilibrium quantum and classical systems, on the theory of integrable systems, and advances in gravitational waves. More than 60 people from leading research centres of Russia, Bulgaria and Slovakia, universities of Moscow, Saint Petersburg, Kazan, and Tomsk took part in the School.

CONFERENCES, MEETINGS, COOPERATION

Eight conferences and workshops and three schools for students and young scientists were organized in 2024:

- DIAS-TH Winter School "Many-Particle Systems: From Condensed Matter to Quarks and Stars" (29 January – 3 February, Dubna);
- International School "Nuclear Theory and Astrophysical Applications" (11–17 February, Dubna);
- International Workshop "Problems of the Modern Mathematical Physics — PMMP" (19–23 February, Dubna);
- Scientific Session of the Nuclear Physics Section of the Physical Sciences Division of RAS "Physics of Fundamental Interactions" (1–5 April, Dubna);
- 22nd International Seminar on High Energy Physics "Quarks-2024" (20–24 May, Pereslavl-Zalessky);
- 74th International Conference on Nuclear Physics "Nucleus-2024: Fundamental Problems and Applications" (1–5 July, Dubna);
- International Conference "Modern Problems of Condensed Matter Theory" (15–19 July, Dubna);
- International School "Advanced Methods of Modern Theoretical Physics: Integrable and Stochastic Systems" (21–26 July, Dubna);
- International Workshop "Supersymmetries and Quantum Symmetries — SQS'24" (29 July – 3 August, Dubna);
- IV International School-Workshop on Few-Body Systems (30 September – 4 October, Khabarovsk);
- 12th KLTP/CAS–BLTP/JINR Joint Workshop on Physics of Strongly Interacting Systems (4–8 November, Huzhou, China).

11–17 February. International School "Nuclear Theory and Astrophysical Applications"

19–23 February. International Workshop “Problems of the Modern Mathematical Physics”

COMPUTER FACILITIES

In 2024, more than ten new PCs with 12th and 14th generation Intel processors were installed at workplaces. To expand the capabilities of the BLTP file server, high-capacity disks and a system unit with a modern processor were purchased. Wi-Fi access points were replaced with faster 802.11ax devices in large auditoria of BLTP. New web server bltp.jinr.ru was launched. An information kiosk was installed in the BLTP lobby. Subscriptions for updates to Maple and OriginPro programs were extended for 1 year.

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VEKSLER and BALDIN LABORATORY of HIGH ENERGY PHYSICS

In 2024, the staff of the Veksler and Baldin Laboratory of High Energy Physics primarily focused on the construction, development and commissioning of separate units of the accelerator complex "Nuclotron–NICA" and MPD, BM@N and SPD experimental facilities. Experiments also continued at external accelerators.

MOST IMPORTANT RESULTS IN THE IMPLEMENTATION OF THE NUCLOTRON–NICA PROJECT

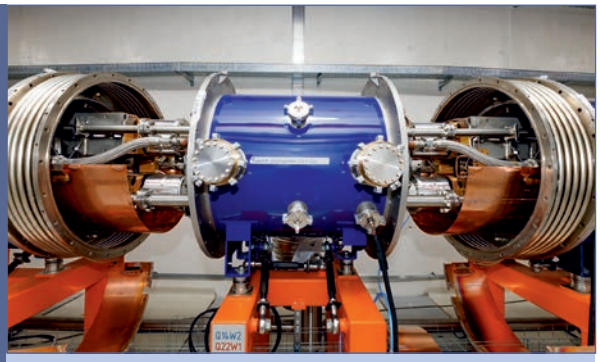
In June 2024, during his visit to the Joint Institute for Nuclear Research, President of the Russian Federation V. Putin initiated the technological launch of the NICA collider. The collider's injection system, launched in 2023, had already demonstrated stable operation in the commissioning run, successfully delivering the accelerated beam to the BM@N experimental facility. Installation of the magnetic-cryo-

Dubna, 13 June. President of the Russian Federation V. Putin on an excursion to the Veksler and Baldin Laboratory of High Energy Physics

stat system, RF stations, and quadrupole lenses of the beam interaction area is well advanced, as is the integration of high-vacuum sections in the collider's East and West arcs. Cryogenic equipment and power supplies are being installed in the collider building, and power lines and energy extraction system are being connected and tested. The engineering infrastructure is nearing completion. Testing of the power supplies of the superconducting magnets began. A detailed programme for the physical launch of the NICA Complex was developed, including the staged tuning of its elements in parallel with the completion of installation of the collider subsystems. The start of tests of the collider technological equipment and the MPD magnet marks the final stage of preparations for the full NICA Complex launch.

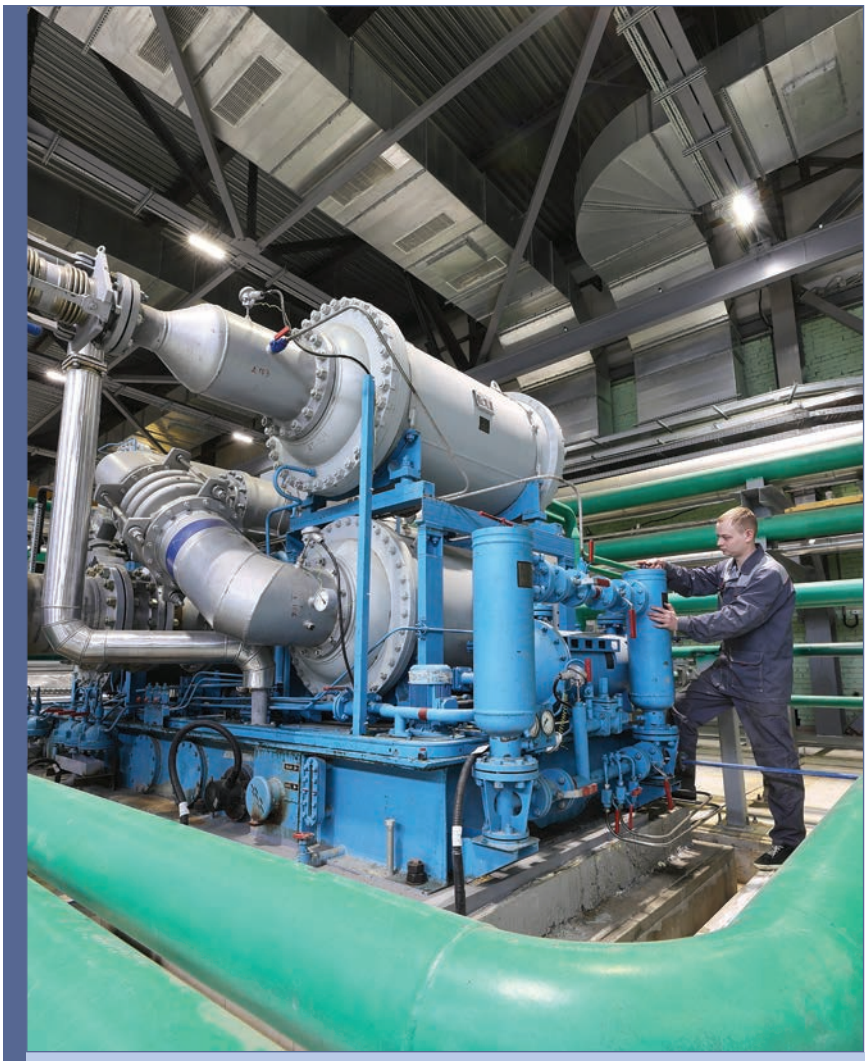
The heavy-ion source, linear accelerator, the Booster, and the Nuclotron are undergoing upgrade to substantially increase the intensity of accelerated heavy-ion beams. A multiturn injection method for beam accumulation in the Booster was developed.

During the R&D work, a unique fast-cycling superconducting magnet was developed, capable of producing a maximum field of up to 1.8 T with the change rate of 10 T/s. This unparalleled magnet enables further increases in beam intensity within the NICA collider [1–6].



Part of the collider's magnetic-cryostat system

The crucial result for the **MPD** Collaboration was successful cooling of the superconducting solenoid, which is the main unit of the facility (length — 7 m, diameter — 5 m, weight — 70 t) to operating temperatures. The cooling system is made up of the solenoid with pipelines and manifolds located on the support cylinder and thermal shields, the control Dewar vessel, which is a buffer for the input of



A new cryogenic compressor station

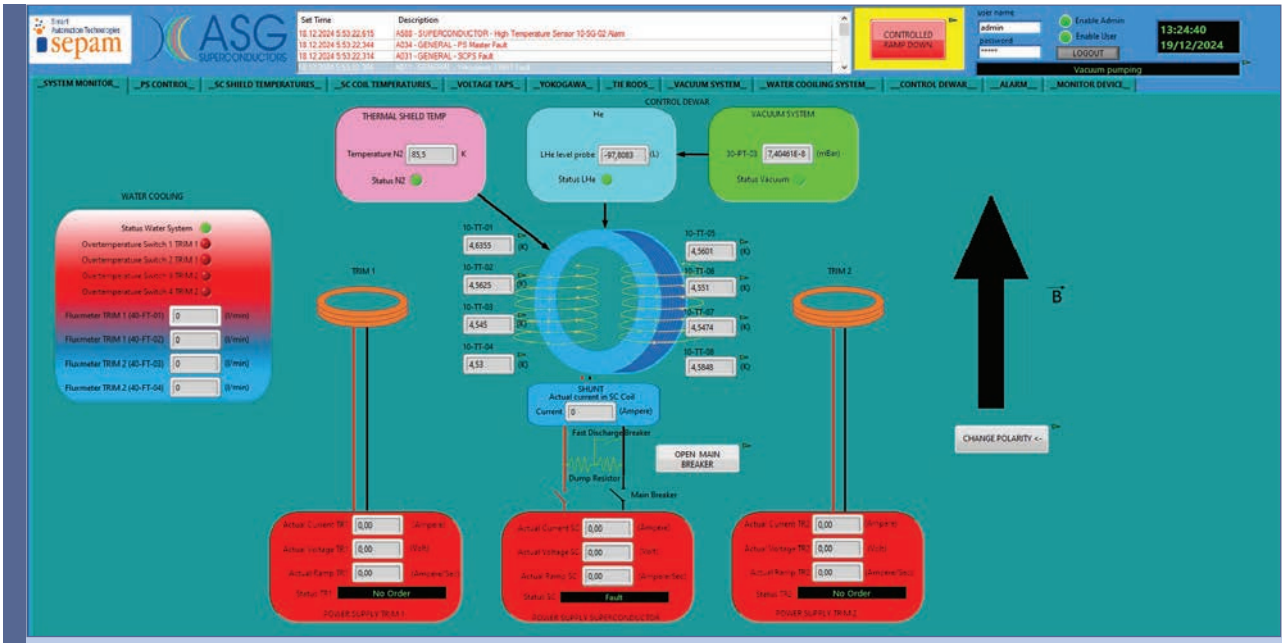
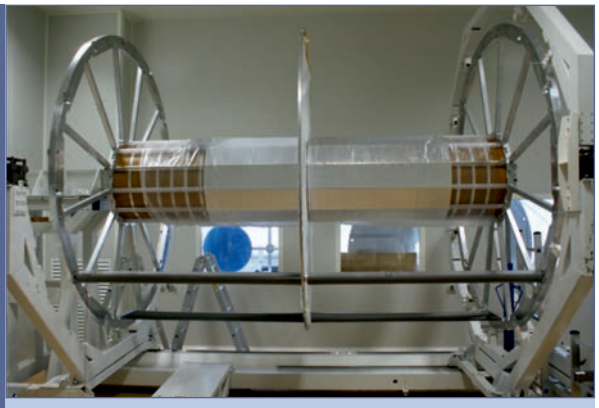


Fig. 1. The ASG main screen of the MPD solenoid

cryogenic liquids and current into the solenoid, a satellite refrigerator providing helium supply with a given flow rate and temperature, a nitrogen temperature control system for the solenoid thermal shields, cryogenic and thermal pipelines, storage and supply tanks for technical gases, a vacuum system, and a control and protection system. The team assembled the equipment, performed required calculations, refined the software displaying all vital parameters of the solenoid. Figure 1 shows the main screen of the operator. The data shown on the screen correspond to the stable operation of the solenoid, cooled to superconductivity temperatures in December 2024. The figure shows that the coil is cooled to approximately 4.5 K, the nitrogen shields are at 85 K, and the vacuum inside the solenoid is $7 \cdot 10^{-8}$ mbar.

According to the results of tests of the solenoid at nitrogen temperature, it was discovered that there were no "cold" leaks, and an increase in temperature is no more than 1 K/day inside the solenoid when operating with only nitrogen shields. The work continued on connecting signal and supply cables to the sources of the current supply to the solenoid and correction coils, the dump resistor and the quench detection sensor. Along with the volume meter, stationary magnetic field monitors are being developed that will be installed on the inside of the solenoid cover.



Gluing of two flanges and the HV electrode with the cylinders C1–C2

The time-projection chamber (TPC) is the main tracking detector of the MPD facility. The TPC reconstructs the tracks of charged particles and their identification is performed by specific energy losses in the detector working gas. The TPC consists of four cylinders (made of Kevlar) with high rigidity (deflection in the centre is no more than 0.1 mm) and small amount of material budget on the particle track (0.4 g/cm^2).

Twelve chambers are installed on each TPC endcap. The relative nonparallelism of two flanges and the high-viltage (HV) electrode between each other is no more than ± 0.5 mm. Twenty-four tubes of the field cage system are installed on the inner diameter of TPC. Twenty-four tubes of external diameter are being prepared for installation. Micro-mirrors of the TPC laser calibration system are installed in eight tubes. To date, the team produced three test benches with DAQ from ROC. Figure 2 shows a visual representation of the RMS noise of the readout electronics channels connected to ROC pads. The red colour indicates channels with a small excess of noise relative to the reference value RMS = 1.2ch ADC.

Work continues on the integration of the TPC detector equipment into the MPD facility. There are eight racks for the TPC equipment on the 4th floor of the North electronic platform. An arrangement scheme for these eight racks was developed. The cooling systems for the TPC and ECal detectors are located on the South platform (Fig. 3).

Dubna, 24 May. NICA Complex

The time-of-flight (TOF) system is the MPD basic system for the identification of charged hadrons. In its initial configuration, the TOF will be represented as a cylinder about 6 m long and 3 m in diameter, assembled from 28 modules (Fig. 4). Each TOF module consists of 10 identical multigap resistive plate chambers (MRPCs) with 24 readout channels each. Production of 300 MRPCs and 28 TOF modules was completed in 2023. All TOF modules were undergoing long-term cosmic ray testing throughout 2024. Installation of the TOF modules in the magnet will begin after the team completes the installation of the electromagnetic calorimeter (ECal). Each TOF module will be mounted in its place on both sides of the magnet yoke. The installation will be carried out using the already constructed mobile support structure (Fig. 5). The TOF detectors will operate with a nonflammable gas mixture containing 90% $C_2H_2F_4$ + 5% *i*-C_4H_{10} + 5% SF_6. The total volume of gas in the TOF barrel is approximately 3000 l including the volume occupied by the detectors. Due to this large volume of gas, it was decided to use a closed loop gas supply system with recirculation and purification of the gas mixture. In 2024, the team completed the purchase of equipment for the gas

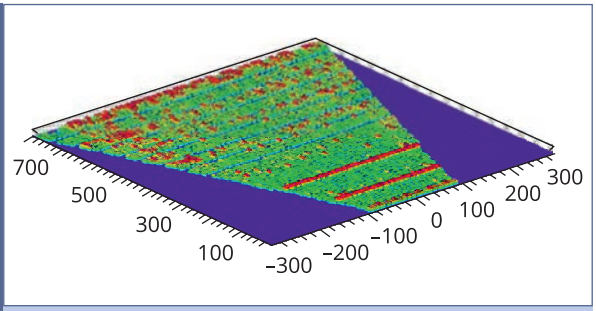


Fig. 2. RMS noise for 3968 ROC channels

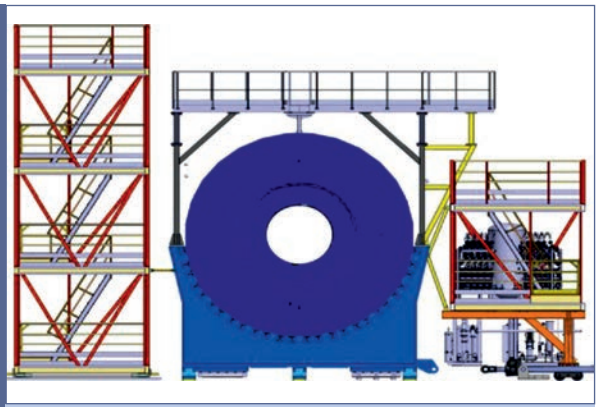


Fig. 3. MPD platforms for electronic equipment

Fig. 4. TOF geometry in MPDRoot

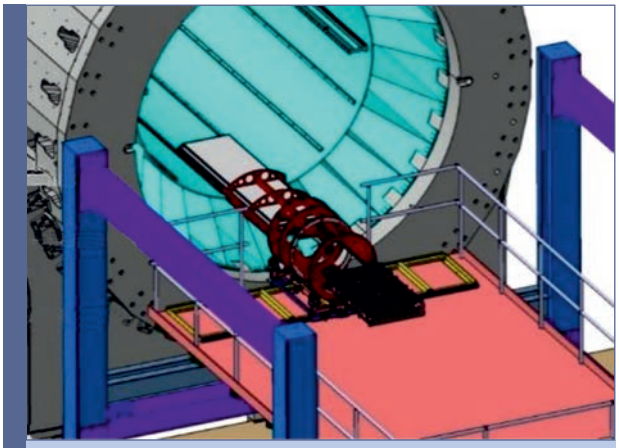
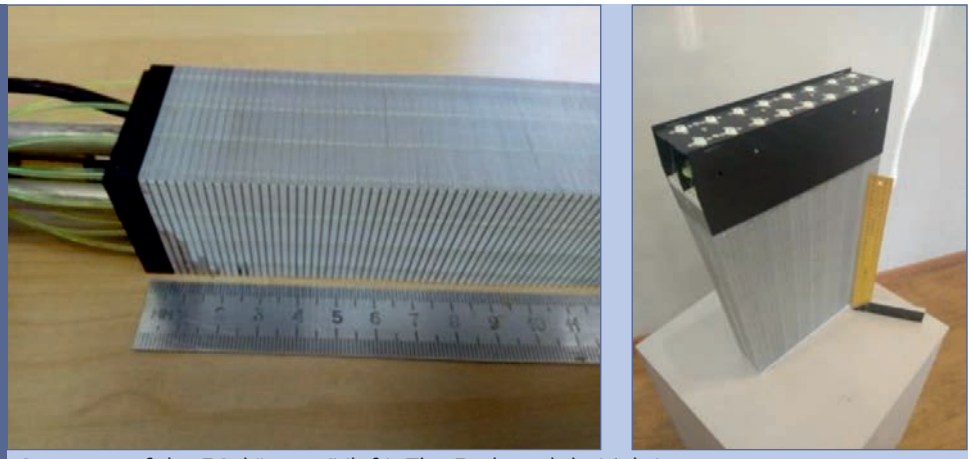


Fig. 5. Equipment for TOF installation

system, and installation work is underway. In 2024, an air cooling system for on-chamber electronics was designed.

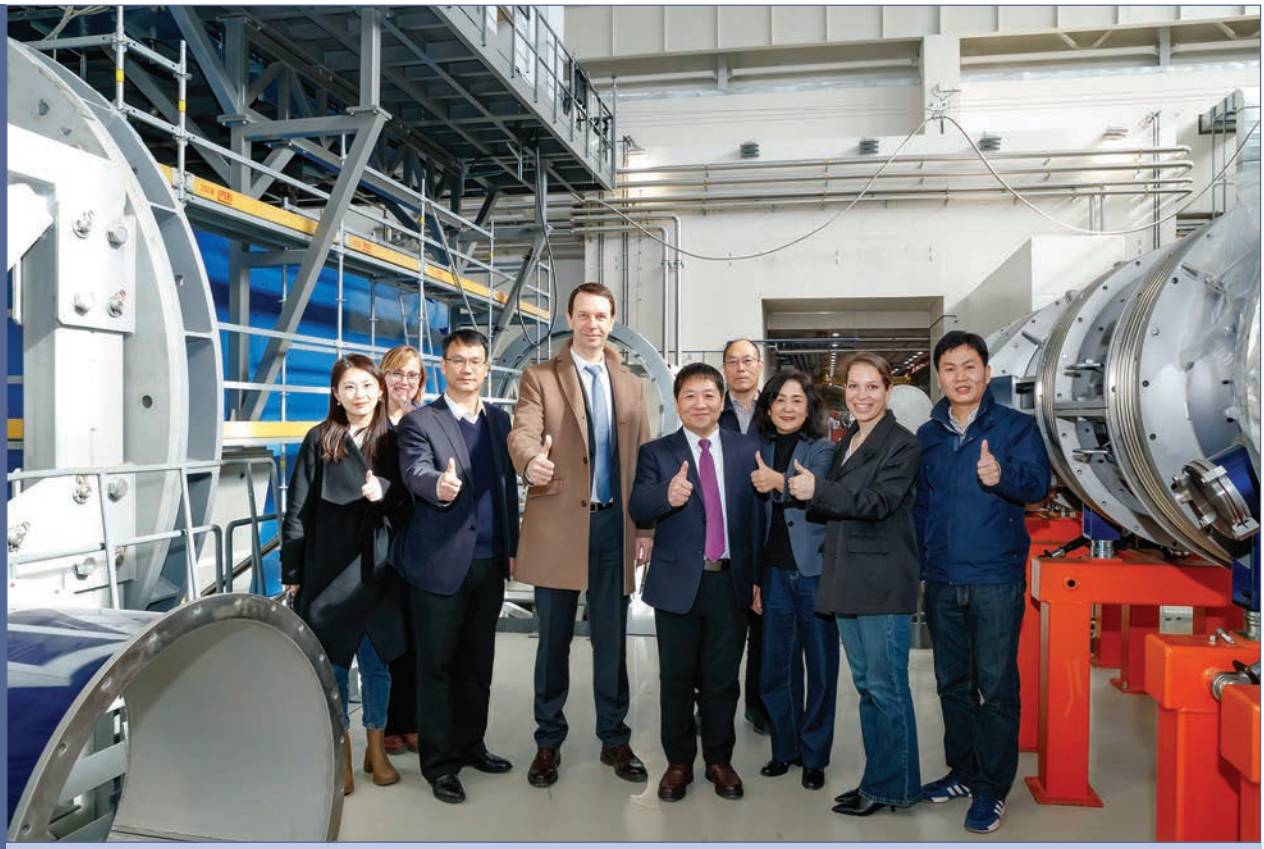
ECal is a cylindrical, large-size (6 m long and 4.5 m in diameter) calorimeter of the "shashlik" type. Designed with projective geometry, it overlaps the central pseudorapidity region $|\eta| < 1.2$. Optimized for accurate measurements of hit positions and energies of photons and electrons within the 40-MeV to 2–3-GeV range, the ECal is finely segmented, consisting of 38 400 cells ("towers") assembled into modules, to enable operation under conditions of high secondary-particle multiplicity in central Au + Au collisions. Each "tower" consists of alternating layers of 210 polystyrene scintillators and 210 lead plates, with 16 wave length shifting (WLS) fibers for collecting the scintillation light. The total thickness of ECal is limited to 11 X_0 by the facility's geometry, with energy leakage from the calorimeter not exceeding 10–12%.

Each ECal module is made up of 16 "towers" glued together. The geometry of each module varies depending on its position along the beam direction relative to the beam interaction point. In total, the ECal will consist of 2400 modules of eight different types. Module production is divided between sites in Russia and China. After manufacturing, each module is pre-calibrated and tested with cosmic muons. To date, 1499 modules have been tested. Tests of prototype modules have been previously conducted with electron beams at DESY (Hamburg, Germany) and LPI (Troitsk, Russia). Recent tests of a single ECal module with a relatively low-energy electron beam in Troitsk showed good agreement with MC simula-



Structure of the ECal "tower" (left). The Ecal module (right)

Fig. 6. The arrangement of modules in a half-sector



28 March. Visit of representatives of the Hefei Institutes of Physical Science (HFIPS) and the Institute of Plasma Physics of the Chinese Academy of Sciences (ASIPP)

tion results, which has allowed making a preliminary estimate of the expected energy resolution of ECal:

$$\Delta E/E \approx \frac{3.0\%}{\sqrt{E\,(\text{GeV})}} \oplus 2.4\%.$$

The ECal is geometrically divided into 25 sectors or 50 half-sectors. Each half-sector consists of 48 modules of eight different types (Fig. 6). The modules are placed in a half-sector container ("basket") made of glass fiber. Approximately 800 modules were manufactured at four institutes in China, and 1320 modules were manufactured in Russia (Protvino, Armul, and Tenzor). By the end of 2024, these modules were assembled into 40 half-sectors, which is 80% of the total number required for the ECal. Contracts for the production of the remaining components and modules have been signed with domestic manufacturers.

Specialized equipment was designed and produced to install ECal half-sectors into the MPD support frame. This equipment enables precise three-dimensional positioning and rotation of a 1.5-t

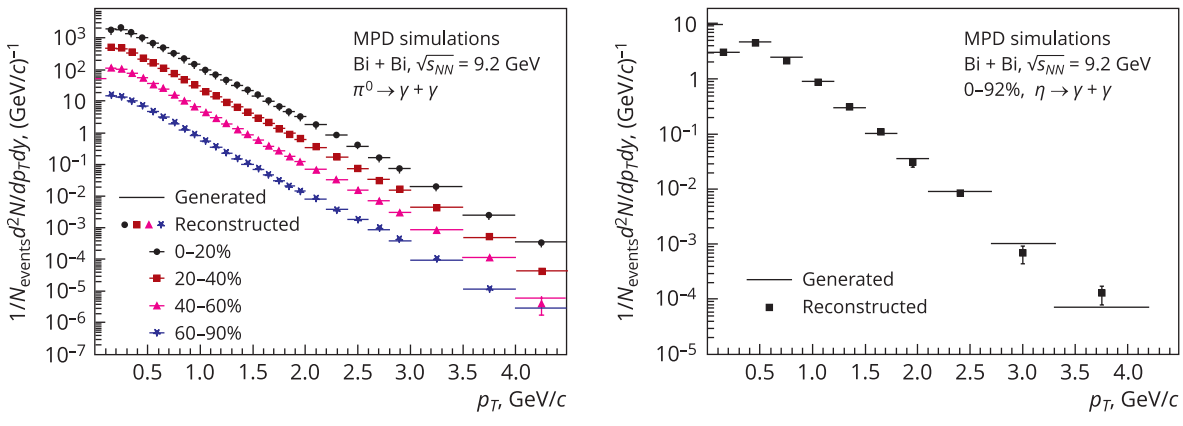


Fig. 7. Differential production spectra of π^0 and η mesons for Bi + Bi collisions at $\sqrt{s_{NN}}$ = 9.2 GeV. The results for π^0 meson are shown for various centrality intervals. Measured values marked by dots are compared to the true, generated spectra, which are represented by histograms

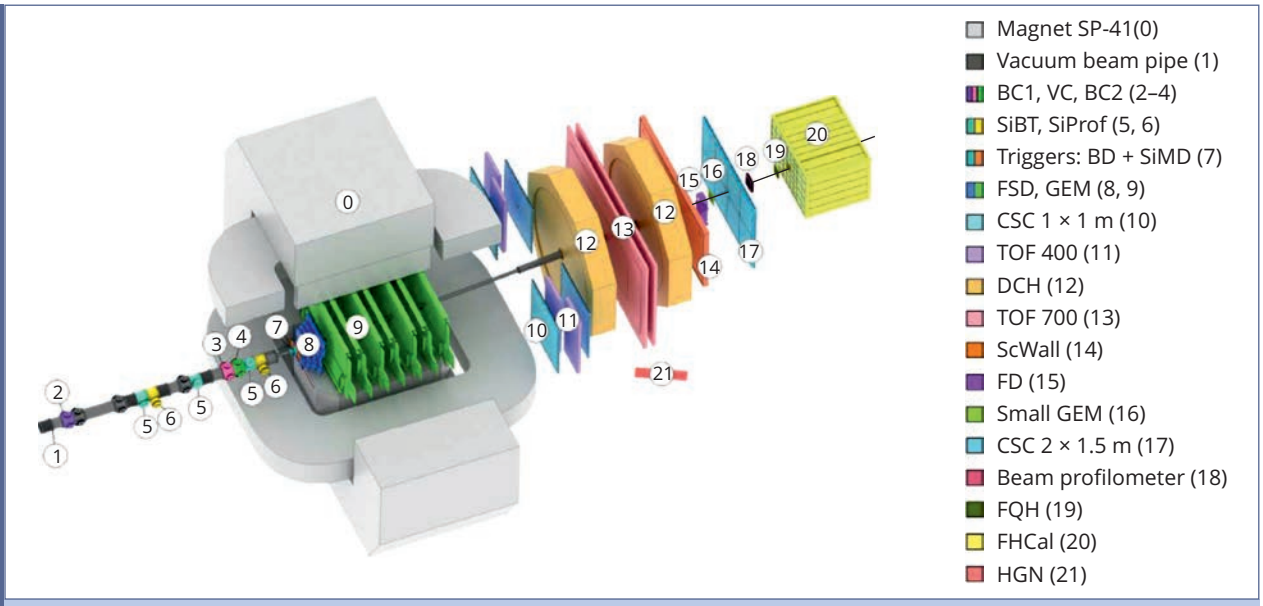


Fig. 8. Full configuration of the BM@N detectors in the Xe + CsI run

half-sector, as well as low-friction movement along its axis. The equipment was delivered to JINR in October 2024 for final adjustments.

In 2024, a comprehensive programme was implemented to study the characteristics and physics capabilities of the MPD detector in collider mode with heavy-ion beams. The research findings were presented at international conferences, where Collaboration members delivered over 40 oral reports, and Collaboration paper is currently being prepared for publication [7–11]. As an example, Fig. 7 illustrates the differential yields obtained for reconstructed π^0 and η mesons as a function of their transverse momentum in central Bi + Bi collisions at $\sqrt{s_{NN}}$ = 9.2 GeV. The reconstructed spectra are compared to the generated ones, shown as histograms in the same figure, and do not differ within statistical uncertainties.

Within the framework of the **BM@N** experiment, a paper was published [12] describing the full configuration of the BM@N detectors in the first physical run in the interactions of the Xe ion beam with a CsI target (Fig. 8).

Physical results on studying the production of protons, deuterons and tritons in argon–nucleus interactions at an energy of 3.2 *A* GeV were obtained

Specialized equipment for half-sector installation

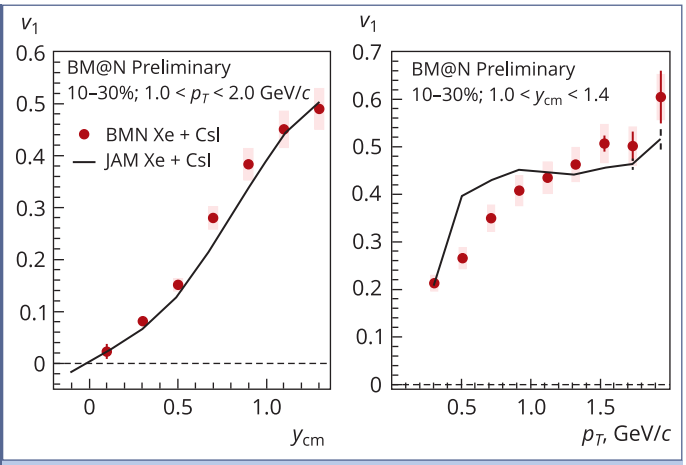


Fig. 9. Direct flow of protons as a function of rapidity (y) and transverse momentum (p_T) in the Xe + CsI interactions with 10–30% centrality at an energy of 3.8 *A* GeV

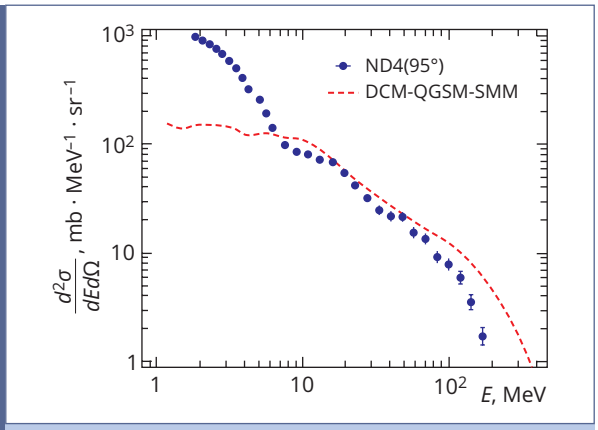


Fig. 10. The differential cross section of the neutron production at an angle of 95° to the beam direction in the Xe + CsI interactions at an energy of 3.8 *A* GeV

and presented at conferences [13]. The team measured the direct flow v_1 of protons in Xe + CsI interactions at 3.8 *A* GeV [14] across various event samples (Fig. 9). The results were compared with the JAM model. The experimental data and predictions of the DCM-QGSM model for neutron emission at large angles are shown in Fig. 10.

The participants of the experiment made more than 20 reports at various conferences. Preparation for runs at the Nuclotron with xenon ion beams at energies from 2 to 3 *A* GeV is currently underway.

In 2024, the **SPD** team finalized the technical design of the facility [15]. The international SPD Detector Advisory Committee conducted an independent review of the document, and the PAC for Particle Physics approved the SPD TDR and recommended the team to begin constructing subsystems for the first stage of the experiment.

Work continued on constructing and testing prototypes of the main subsystems of the facility. The prototype of the SPD muon system module was tested with cosmic muons and prepared for the operation with the beam in the SPD test area. Prototypes of tracking detectors, based on straw tubes and Micromegas, showed the required resolution of 150 and 80 μm, respectively, during tests with hadron beams at CERN. Preparation of sites for mass production of straw tubes in JINR and INP of the Kazakhstan Academy of Sciences is underway. The team produced a prototype of the endcap part of the tracker based on straw tubes and evaluated its mechanical properties. Tests of electromagnetic calorimeter modules are in progress. Documentation for the SPD superconducting solenoid is nearing completion, and preparations are underway to procure equipment for the cryogenic infrastructure of the detector.

In preparation for the second phase of the experiment, an agreement was reached to establish a joint laboratory with JINR on the basis of AANL (Yerevan) for testing and studying the properties of aerogel being developed for the FARICH detector in Novosibirsk.

Important results were obtained in the deployment of the IT infrastructure of the experiment. For the first time, a mass launch of tasks at PNPI cluster within the Grid system was implemented. A laboratory for working with a prototype of the SPD data acquisition system was set up at MLIT.

In 2024, two new members joined the SPD Collaboration: Institute of Physics of the National Academy of Sciences of Belarus and MISIS University. Two Collaboration meetings were held — in Almaty, hosted by INP of the Kazakhstan Academy of Sciences, and at JINR, which were attended by more than 180 participants. During the year, the participants of the SPD project presented more than 30 papers at international conferences and published seven papers in refereed scientific journals [16, 17].

The team of the **DSS** experiment carried out the analysis of experimental data on the angular and energy dependencies of the deuteron analyzing powers A_y, A_{yy} and A_{xx} of deuteron–proton elastic scattering at deuteron energies of 700–1800 MeV obtained at the Nuclotron internal target. Within the framework of the relativistic multiple scattering model, theoretical calculations were performed to interpret the experimental data obtained on deuteron–proton backward elastic scattering, taking into account the excitation of the delta isobar in the intermediate state. The results were presented at the International Conference ICPPA-2024. A paper was prepared for publication in Physics of Atomic Nuclei journal on the results of the analysis of experimental data on the angular dependences of the analyzing power A_y of the quasi-elastic proton–proton scattering reaction at energies of 200–650 MeV/nucleon. The analysis of experimental data on correlations of three charged particles in the Xe + W interaction at an energy of 3.0 GeV/nucleon obtained at the Nuclotron was conducted. The results were presented at the International Conference Nucleus-2024 [18–21].

Tests of the new drift chamber [22] were completed at the **ALPOM2** facility, and the hadron calorimeter was installed in the operating position at the channel in building 205. The upgrade of the data acquisition and processing system continues.

Within the framework of the **HyperNIS–SRC** project, the team started to restore channel 4V: prepared the TDC for the draft radiation safety of the setup; obtained preliminary calculations of the existing biological protection of the experimental zone; restored the beam shatter of the channel; started restoring power supply and water cooling of magnetic optics elements of the channel. The Construction Department together with the SRC and HyperNIS teams created a 3D model of the experimental setup and developed new frame supports for the shoulder detectors of the SRC experiment. The team also replaced the high-voltage power supply system for the proportional chambers with new CAEN NDT1471 power supplies. Preventive maintenance of equipment is in progress. The data collected in 2022 in the SRC experiment at the BM@N facility are being analyzed.

5–8 November. Participants of the 8th Collaboration Meeting of the SPD Experiment

December. Participants in the creation of the NICA Accelerator Complex

The team of the **NA61/SHINE** experiment at CERN put into operation the arm of the time-of-flight detector with a high time resolution (50 ps). The detector was developed and produced at JINR. While analyzing the experimental data of Be + Be collisions, the team calculated the ratios of the yields of K^+/π^+ and K^-/π^- mesons in the energy range of $\sqrt{s_{NN}}$ from 6 to 17 GeV within the framework of the BMLZ (Baldin–Malakhov–Lykasov–Zaitsev) model. This model provides a better description of the experimental data of the NA61/SHINE experiment (Fig. 11) [23–25].

The analysis of experimental data of the experiments **NA48/2** and **NA62** continued.

Clear confirmation of the ultra-rare decay $K^+ \to \pi^+\nu\nu$ was reported. Based on the analysis of data collected in 2016–2022, the fraction of charged kaons decaying into a pion and a pair of neutrinos is preliminarily estimated to be $\left(13.0^{+3.3}_{-2.9}\right) \cdot 10^{-11}$. A total of 51 $K^+ \to \pi^+\nu\nu$ decay candidates were detected in the signal regions, while the expected background is 18^{+3}_{-1} events. The result is about 50% higher than predicted by the Standard Model, but is consistent with it given the overall uncertainty of the measurement (Fig. 12).

Final results of the analysis of the rare decay $K^{00}_{\mu 4}$ that has never been observed earlier were published [26]. From 2437 detected signal candidates with a S/B ratio of about 6, the branching ratio of the decay was determined with high precision. The result for the full phase space $(K^{00}_{\mu 4}) = (3.4 \pm 0.2) \cdot 10^{-6}$ is in reasonable agreement with the R form factor prediction from 1-loop Chiral Perturbation Theory.

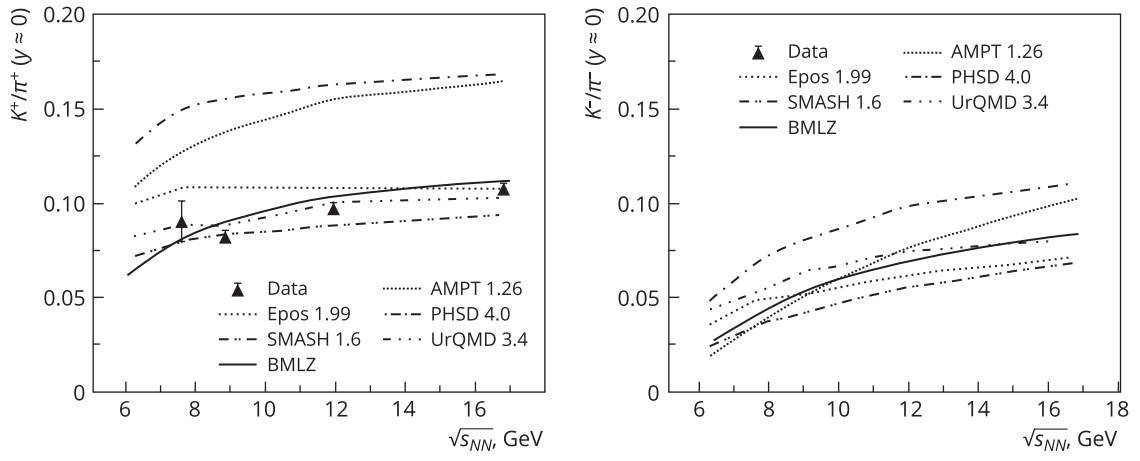


Fig. 11. Dependences of the ratios of the yields of K^+/π^+ and K^-/π^- for Be + Be collisions. Calculations for various models are given

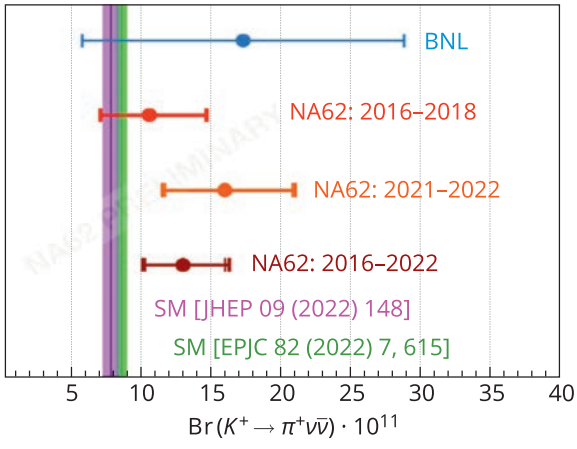


Fig. 12. Comparison of the latest preliminary results of NA62 with earlier measurements and theoretical predictions based on the Standard Model

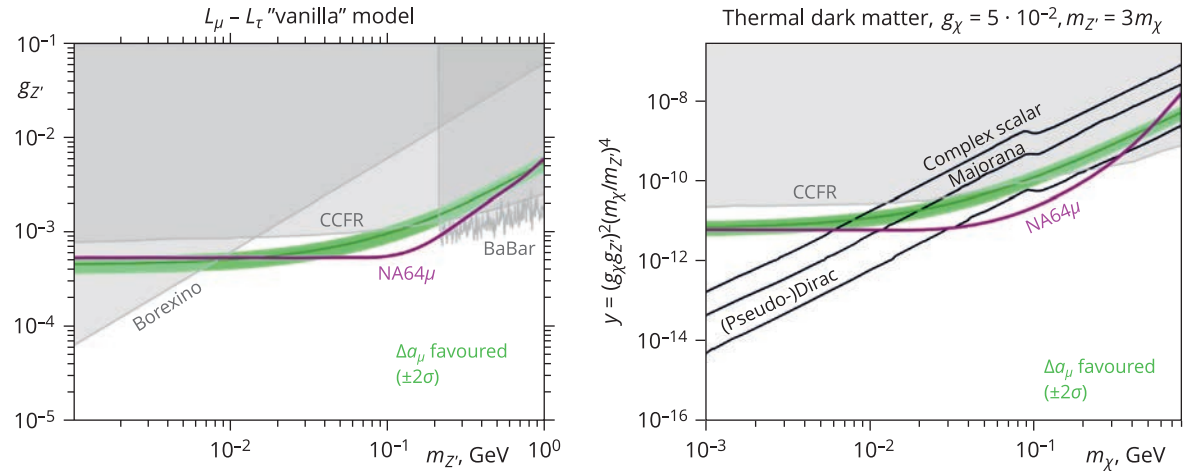


Fig. 13. Left: NA64$_\mu$ 90% CL exclusion limits on the coupling $g_{Z'}$ as a function of the $m_{Z'}$, for the "vanilla" $L_\mu - L_\tau$ model. The 2σ band for the Z' contribution to the $(g-2)_\mu$ discrepancy is also shown. Existing constraints from BaBar and from neutrino experiments such as Borexino and CCFR are plotted. Right: The 90% CL exclusion limits obtained by the NA64$_\mu$ experiment in the (m_χ, y) parameters space for thermal dark matter charged under $U(1)L_\mu - L_\tau$ with $m_{Z'} = 3m_\chi$ and the coupling $g_\chi = 5 \cdot 10^{-2}$ for $2 \cdot 10^{10}$ mot

With the facility configured in beam-dump mode, the NA62 team searched for dark photon decaying in flight to electron–positron pairs using a sample of $1.4 \cdot 10^{17}$ protons on dump collected in 2021 [27]. No evidence for the dark photon signal was observed. The combined result for dark photon searches in lepton–antilepton final states was obtained and the region of the parameter space is excluded at 90% confidence level, improving the previous experimental limits for dark photon mass values between 50 and 600 MeV/c^2 and coupling values in the range from 10^{-6} to $4 \cdot 10^{-5}$.

The JINR group taking part in the **NA64** experiment is responsible for the coordinate detectors based on thin-walled straw tubes and participates in the development of the software system for their online monitoring and DAQ, simulation, reconstruction and analysis of data aimed at searching for the dark photon. In 2024, there were performed two runs on data taking.

One of the new results published in 2024 by the Collaboration was achieved in the analysis of data obtained at the SPS muon beam to probe models related to the explanation of the $(g-2)_\mu$ anomaly due to an additional Z' boson interacting mostly with the 2nd and 3rd lepton generations (Fig. 13) [28, 29].

Based on the results of the work, members of the JINR group delivered numerous reports at international conferences and workshops.

The JINR group participating in the **ALICE** experiment continues studying femtoscopic [30, 31] correlations and the production of light vector mesons in ultra-peripheral Pb–Pb collisions (UPC). The correlation function $C(q)$ was used to analyze femtoscopic correlations of K^+K^- pairs in p–Pb at 5.02 TeV:

$$C(q) = 1 + \lambda\left(C^{\mathrm{FSI}}_{a_0 f_0}(q, R) + C_\phi(q, R)\right),$$

from the Lednicky–Lyuboshits model, where $q = (p_1 - p_2)$, p_1 and p_2 are the 4-momenta of kaons, C^{FSI} is the correlation function in the model to take into account the influence of the final state interaction through the a_0 and f_0 resonances, C_ϕ is the convolution of the Gaussian and Breit–Wigner functions for ϕ-meson production, R is the kaon emission source radius, λ is the correlation strength.

The results of the fitting of the experimental data are given in Fig. 14 for different centralities in comparison with the data obtained earlier for identical kaons. The known strong R decrease is a consequence of the collective effects, predicted in the hydrodynamic models. Some difference in the R values for nonidentical and identical kaon pairs can also be seen, which contradicts the results obtained previously for Pb–Pb collisions. New results were obtained for four-pion ($\pi^+\pi^+\pi^-\pi^-$) coherent photoproduction in Pb–Pb UPC at an energy of 5.02 TeV [32]. The best description of four-pion invariant mass distribution is obtained using two Breit–Wigner (B–W) functions for the contribution of two ρ_0 resonance states and the interference between them. These masses and widths are consistent within the errors with PDG's values of the $\rho_0(1450)$ and the $\rho_0(1700)$. As part of the ALICE upgrade programme, PHOS modules with SiPM detectors (Hamamatsu) and PWO4 single crystals were tested at the CERN SPS. A time resolution of 100 ps and an energy resolution of 1% were obtained with the electron beam in the energy range 1–10 GeV.

The JINR group's participation in the **ATLAS** experiment yielded new results on studies of the Higgs boson production in association with the W/Z boson followed by a decay into a pair of b quarks [33]. Figure 15 shows the measured "signal strength" $H \to bb$, the ratio of the measured cross section to

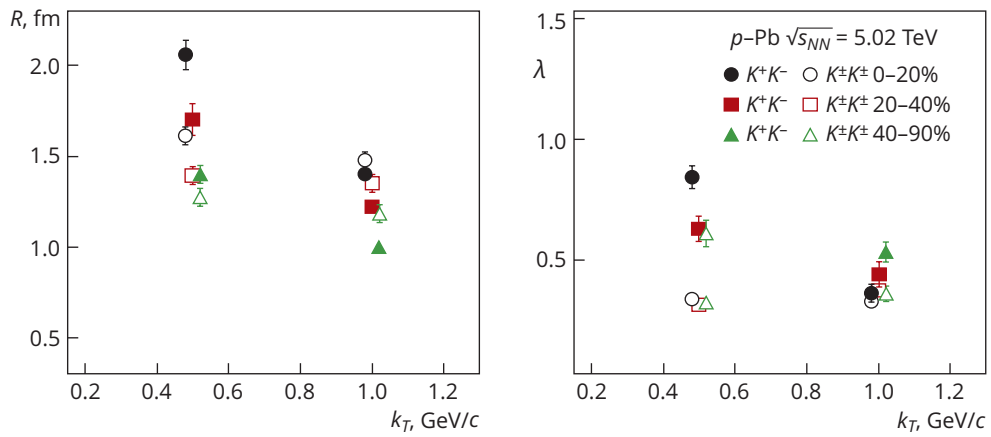


Fig. 14. Parameters R and λ versus pair transverse momentum for different centralities in p–Pb collisions at 5.02 TeV

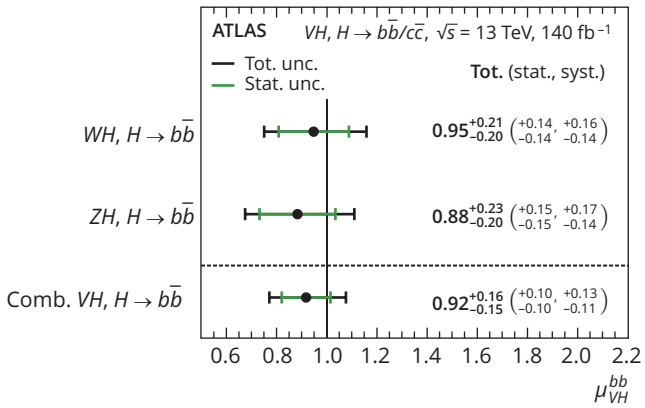


Fig. 15. Measured signal strength values in VH processes ($V = W/Z$) and their combination

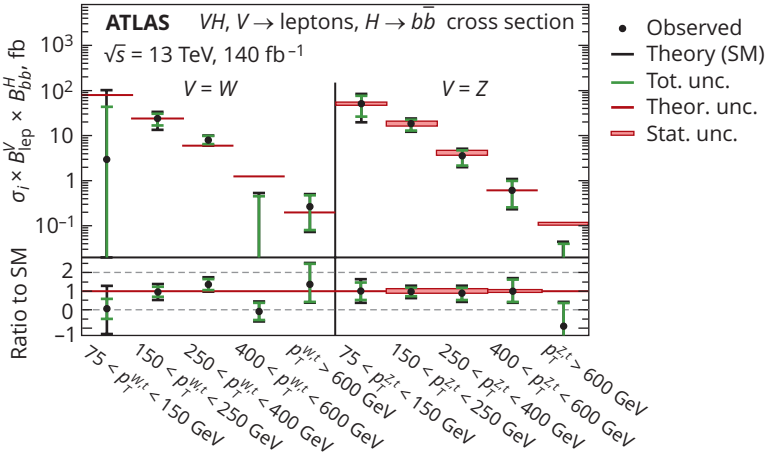


Fig. 16. Cross section of the VH signal process as a function of the transverse momentum p_T^V

Thermally insulated chambers of the stand for testing cassettes of the high granularity calorimeter HGCal, CMS

that expected in the Standard Model (SM), for *WH* and *ZH* processes, individually and combined. The observed (expected) significance of the signal in the *ZH* process was 4.9 (5.6) standard deviations, and in the *WH* process — 5.3 (5.5).

The cross section of the signal process was measured for different transverse momentum regions of the vector boson *V* and is presented in Fig. 16. In general, the measured cross section values are in good agreement with the SM predictions within 90%.

The JINR team participating in the **CMS** experiment continued searching for dark matter (DM) particles at $\sqrt{s}$ = 13 TeV with Z^0 and missing transverse energy in the final state. The most stringent upper limits on the cross section of DM–nucleon interactions were set in combination with other channels (Fig. 17).

The analysis of muon pair spectra continued, aimed at searching for signals of new physics and verifying the predictions of the Standard Model [34, 35]. The complete statistics of Run 3 data at the LHC with the total energy of colliding protons $\sqrt{s}$ = 13.6 TeV for dimuon events were processed. The agreement of the experimental data with the predictions of the SM is shown (Fig. 18).

The experimental search for a candidate for dark matter continued within the framework of the Inert Doublet Model using *pp* collisions data with an energy of 13 TeV (138 fb^{-1}). The expected limits on the cross section were obtained depending on the model parameters [36].

The Run 2 analysis of Higgs boson search produced via weak vector bosons fusion (VBF) with subsequent decay into a pair of bottom quarks ($H \to bb$) was published [37]. The team performed the analysis with 2016 and 2018 CMS data of *pp* collisions at 13 TeV corresponding to ~ 91 fb^{-1} integral luminosity. The VBF signal is observed with a significance of 2.4 standard deviations (σ) relative to the pure background prediction, while the expected significance was 2.7 σ.

Dilepton data analysis was ongoing to establish the new limits for the anomalous lepton flavour violating (LFV) constants within the effective field theory (EFT) approach and its various extensions [38]. The selection procedure was validated using datasets with open access from CMS and ATLAS. The analysis of the polarization effects was performed in the reachable Run 3 limits for the anomalous triple gauge boson couplings in the reaction of the production of polarized *W* bosons within the effective field theory approach. The first paper of the CMS Collaboration on the CP violation in charm sector at $\sqrt{s}$ = 13 TeV was completed and submitted for publication. Using Run 3 data, additional channels and new D^0-meson flavour tagging were studied for the subsequent analysis. A method for calculating the model uncertainty for measuring the fractions of quark (*q*) and gluon (*g*) jets was proposed and implemented in the CMS data analysis [39–40].

The JINR group participated in the maintenance and operation of the cathode strip chamber (CSC) detectors of the endcap muon system (ME) and the hadron calorimeter (HCal). During data collection, several actions were taken to ensure reliable operation of HCal: regular monitoring of data quality, signal amplitude alignment, and calibration of detector channels. In addition, HCal laser calibration system

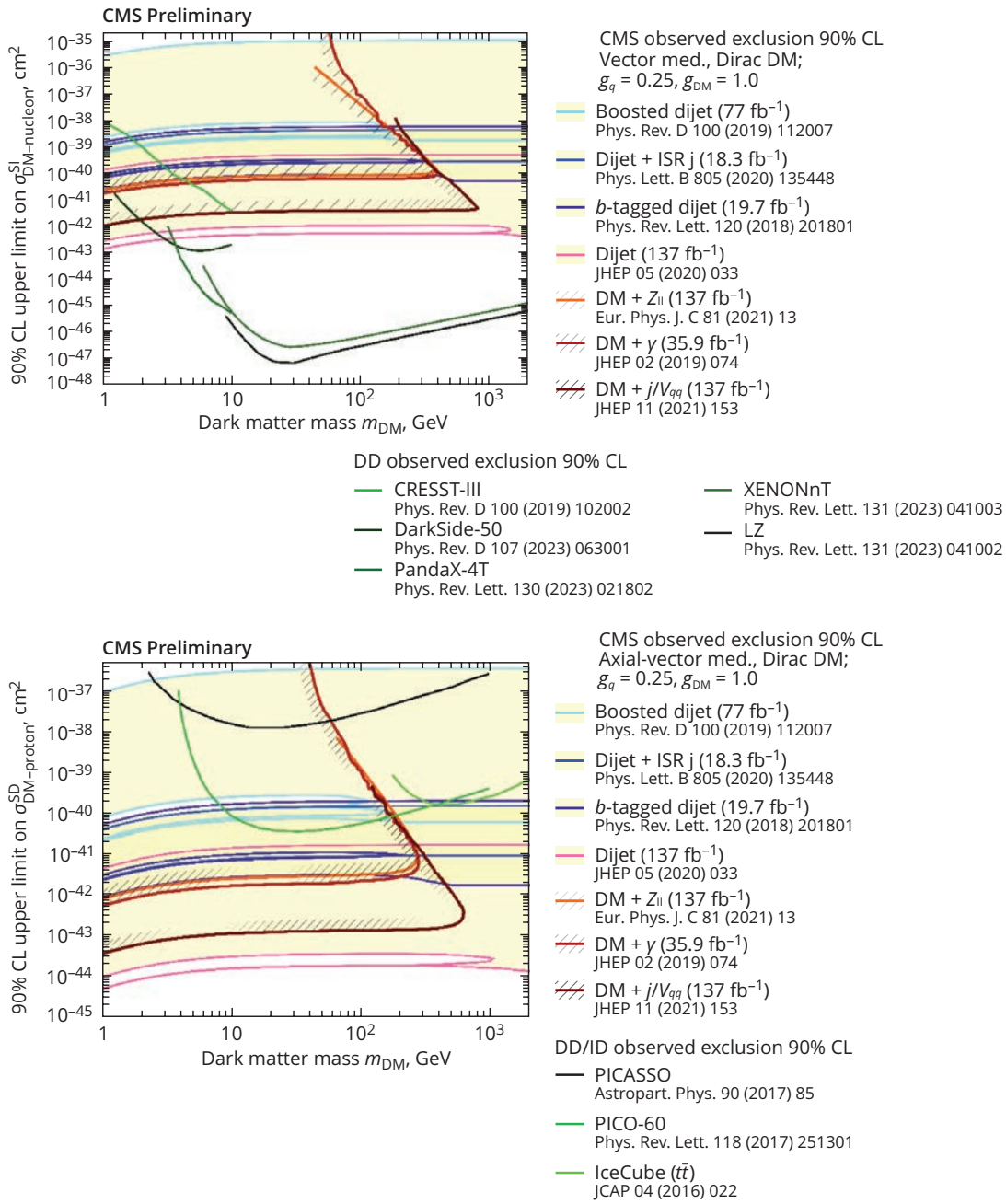


Fig. 17. Upper limits on the cross section of DM–nucleon interactions. The CMS contour is for both vector (top) and axial-vector (bottom) mediators, and Dirac DM with couplings g_q = 0.25 and g_{DM} = 1.0. The exclusion contour is compared with limits from the noncollider underground experiments

was relocated to the new experimental hall and commissioned. The analysis of Run 3 experimental data shows stable and efficient operation of ME CSCs. As part of the CMS detector upgrade for operation in the high luminosity conditions of the LHC (HL-LHC), the JINR group is actively involved in the construction of the high granularity calorimeter (HGCal) and in the upgrade of the muon endcap system.

JINR's grid infrastructure for CMS, including Tier-1 and Tier-2 centres, was actively used for simulating, processing and storing CMS experimental data. In 2024, the Tier-1 system processed more than 2.1 billion events, which is the second value among all Tier-1 centres for the CMS experiment in the world. More than 1.2 million CMS data analysis and simulation tasks were successfully performed at JINR's Tier-2. In 2024, JINR physicists made a defining contribution to the preparation of 35 scientific papers. The results of the work were presented in more than 50 reports at various conferences, workshops, and seminars.

The **STAR** Collaboration studied two-pion interferometry in Au + Au collisions at 3.0–3.9 GeV and obtained the dependences of the correlation pa-

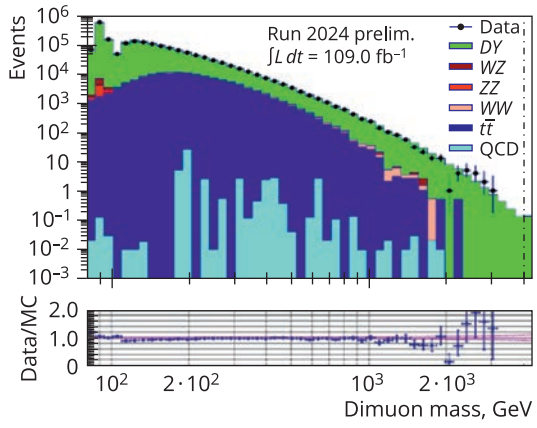


Fig. 18. Distribution of dimuon invariant mass at $\sqrt{s}$ = 13.6 TeV with a total integrated luminosity of 109 fb^{-1} (2024 data)

rameters — correlation strength (λ) and femtoscopic radii (R_{out}, R_{side}, R_{long}) — on the pair transverse momentum, pair rapidity, collision centrality (0–10%, 10–30%, 30–50%), and collision energy. Figure 19 shows the dependence of these parameters on the collision energy for pions produced in the central rapidity region $|y| < 0.5$ with average transverse momentum of 0.2 GeV/c in the most central (0–10%) Au + Au collisions. Data from other experiments are given for comparison. The analysis revealed the dependence of identical pion femtoscopic parameters on rapidity and collision energy at $\sqrt{s_{NN}}$ = 3.0–3.9 GeV [41], a decrease in R_{side} with increasing rapidity, and the difference between measured radii for $\pi^-\pi^-$ and $\pi^+\pi^+$ pairs at these energies.

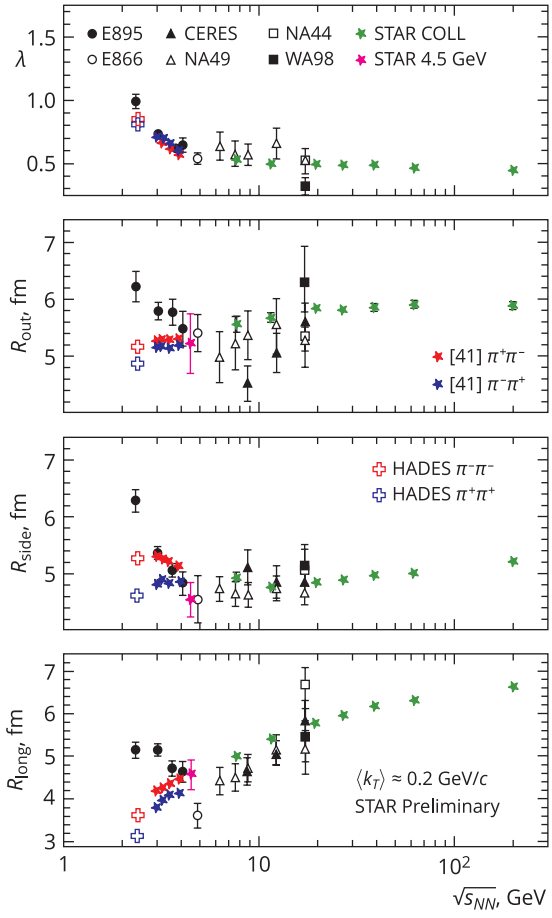


Fig. 19. Energy dependences of pion femtoscopic parameters for central Au + Au, Pb + Pb, and Pb + Au collisions for midrapidity and transverse momentum $k_T \sim 0.2$ GeV/c

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DZHELEPOV LABORATORY of NUCLEAR PROBLEMS

NEUTRINO PHYSICS AND RARE PHENOMENA, ASTROPHYSICS

After the completion of the 2024 Baikal Winter Expedition, the number of detecting optical modules in the **Baikal-GVD** Deep-Underwater Neutrino Telescope exceeded 4100, and its effective volume for detecting events from high-energy neutrinos (over 100 TeV) is now more than 0.6 km^3.

The analysis of cascade events registered by the detector in the configurations of the years 2018–2023 allowed us to conclude that the flux of galactic neutrinos with an energy of above 200 TeV is considerably higher than predicted by the current models. This Baikal-GVD result is confirmed by the analysis of open-access IceCube data with an energy of above 200 TeV (Fig. 1). The combined analysis of these two experiments indicates the relevance of elaborating new conceptions of the origins of cosmic rays in our Galaxy and their distribution and requires more precise experimental measurements [1].

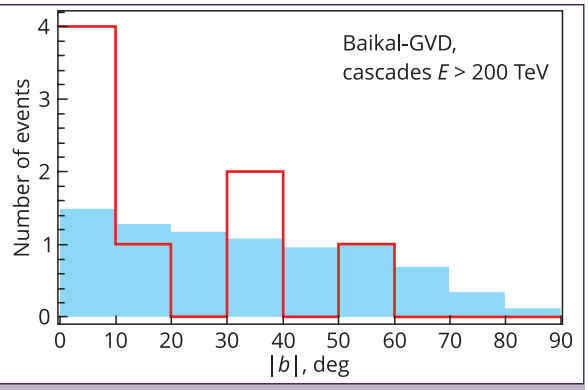

Fig. 1. Distribution of the Baikal-GVD cascade events with the energy of above 200 TeV in the galactic latitude ($|b|$ value): observable ones (red histogram) and expected ones (shaded)

Lake Baikal, 6 March. Participants of the Baikal-GVD project working meeting at the ice camp on the Neutrino Telescope deployment. *Photo: © Irkutsk State University*

Dubna, 30 May – 2 June. Participants of the Baikal Collaboration Meeting

Within the **JUNO** experiment, the assembly of the central detector (35 m in diameter) and the electronics assembly (18 000 photomultipliers) have been completed. The filling of the detector began in December 2024 and will last until September 2025. Then physical data acquisition will begin. In 2024, a new estimate of the JUNO sensitivity to neutrino mass ordering was obtained, that takes into account the most accurate and up-to-date characteristics of the detector: JUNO will reach 3σ within seven years of data acquisition [2]. Work was underway [3] to prepare silicon photomultipliers for the near TAO detector. The JINR group successfully and fully fulfills its obligations concerning preparation of the JUNO experiment.

In 2024, the data analysis results were presented concerning measurement of neutrino oscillation parameters in accelerator neutrino experiments, in which JINR employees played an active role. The **NOvA** and **T2K** Collaborations measured a number of oscillation parameters with the leading accuracy. In addition, these Collaborations presented the first joint analysis of measuring the parameters of three-flavor neutrino oscillations. Until now, no neutrino experiment has performed a full-fledged joint analysis of data with other experiments. The thus obtained values of the neutrino oscillation parameters are more accurate compared to individual results.

Lake Baikal, April. Installation of a garland of optical modules of the Baikal-GVD Neutrino Telescope

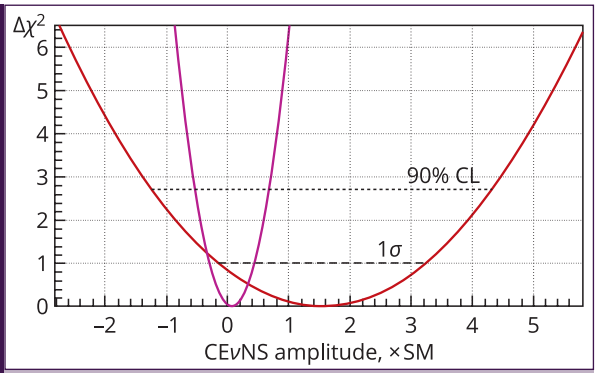

Fig. 2. Profiles of χ^2 statistics from the intensity of the CEνNS predicted spectra for the fit of the residual spectrum to the CEνNS prediction shapes: CONUS quenching factor model (red), Dresden-II model (magenta)

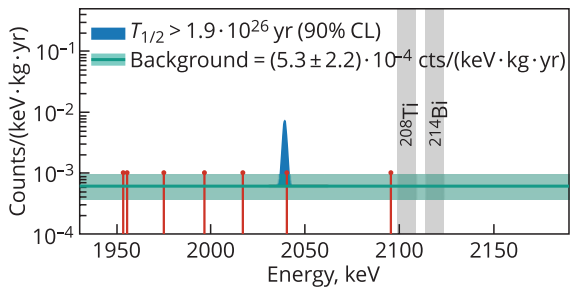

Fig. 3. Energy spectrum of LEGEND-200 in the ROI

The **FASER** experiment continues to successfully collect and analyze data. In 2024, the muon neutrino interaction cross section and neutrino fluxes were measured in the LHC energy range [4].

In the **DsTau** experiment, the developed analysis was validated using the pilot data set, and results were obtained from the study of proton–nucleus interactions [5].

New constraints on the coherent elastic reactor antineutrino–nucleus scattering effect (CEνNS) were obtained from the analysis of the data taken in 2022–2023 in the ***ν*GeN** experiment (Fig. 2). No significant difference of spectra in the region of interests (ROI) with the reactor on and off was found [6, 7]. The new limits on the number of counts from CEνNS events do not confirm the positive result of the experiment at the Dresden-II reactor. The sensitivity to the search for the neutrino magnetic moment was determined [8]. Additional investigations of the background conditions at the Kalinin NPP were performed, and a new muon telescope for cosmic muon fluxes was created.

The **DANSS** experiment achieved record statistics of 7.7 million registered antineutrino events from reactor Unit 4 at the Kalinin NPP, which allowed obtaining new restrictions on the parameters of sterile neutrino oscillations [9]. The performance of the polystyrene scintillation cells of the detector for 6.5 years of measurements was also analyzed. The measured degradation of the light output is (0.55 ± 0.05)% per year, which is significantly lower than in similar experiments. The wavelength-shifting fibers show a reduction in the light attenuation length of (0.26 ± 0.04)% per year [10].

In 2024, the **Ricochet** (cryogenic setup, shields and supplementary equipment) assembly at the ILL nuclear reactor site was completed. Commissioning and test runs are underway at ILL (Grenoble, France) with two NTD-HPGe detectors at ~ 20 mK. The detectors have the energy resolution at the level of ~ 35 eV [11]. Further optimization with the HEMT-based preamplifier is aimed at achieving the level of 20 eV, the leading resolution for CEνNS. The reactor ON/OFF data are used for the first *in situ* detector performance evaluation.

In early 2024, the first phase of the **LEGEND** experiment **(LEGEND-200)** at the Gran Sasso National Laboratory (Italy) continued to accumulate data with 101 enriched germanium detectors (~ 140 kg of ^{76}Ge). The sensitivity of the experiment (LEGEND, GERDA and Majorana combined fit) reached $2.8 \cdot 10^{26}$ yr, and the combined limit on the half-life of $0\nu\beta\beta$ decay was $> 1.9 \cdot 10^{26}$ yr (Fig. 3).

The estimated background index of the experiment, although still the best in the world, exceeds the desired values so far. Therefore, the project switched to searching for and evaluating possible sources of elevated background. Several special data sets were conducted, followed by a complete disassembly of the detector array and the new assay. Then, with the determining participation of JINR specialists, the argon veto system was repaired and restarted. It is planned to reassemble the array of enriched germanium detectors and restart the data taking.

Within the **MONUMENT** project together with German (Technical University of Munich, TUM) and Swiss colleagues (Paul Scherrer Institute, PSI) and a group from Malaysia (University of Technology Malaysia, UTM), data analysis was carried out during 2024 [12]. A publication on the total muon capture rates in ^{136}Ba and ^{76}Se is under preparation.

The **CUPID-Mo** experiment has been performed in the EDELWEISS cryostat at the LSM underground laboratory (France). The dual read-out bolometric technique was exploited to study ^{100}Mo double-beta decay emitter with an exposure of 1.47 kg · yr. In 2024, several noticeable results were obtained using the accumulated data. New best limits were set on $0\nu\beta\beta$ decays with the emission of one or more Majorons, $2\nu\beta\beta$ decay with Lorentz violation, and $2\nu\beta\beta$ decay with a sterile neutrino emission [13].

The **SuperNEMO** Demonstrator at LSM (France) is now taking data with the fully operating tracker and calorimeter from a 6.3-kg ^{82}Se double-beta source. The time and energy calibration of the detector is performed using calibration sources. The internal and external backgrounds are also being studied, which is vital for separating them from the desired $\beta\beta$-decay signal.


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Dubna, 14 December. Festive evening dedicated to the 75th anniversary of the Dzhelepov Laboratory of Nuclear Problems

The employees of the Scientific and Experimental Department of Nuclear Spectroscopy and Radiochemistry are discussing the use of a spectrometric amplifier in future measurements

To reduce radon-induced backgrounds, an anti-radon tent has been installed around the detector, which is filled with radon-free air. To suppress the background from the external gamma flux, a gamma shielding made of iron plates with a thickness of 18 cm was installed. A neutron shielding made of 50-cm-thick water-filled polyethylene tanks in conjunction with 20-cm-thick polyethylene plates was also installed.

ELEMENTARY PARTICLE PHYSICS

Within the **ATLAS** project, the experimental data on 13-TeV *pp* collisions recorded during LHC Run 2 with lepton + jet in the final state have been analyzed. Potential contributions to the observed spectra from quantum black holes (QBH) with masses over 2 TeV are studied. Good agreement between the experimental data and the Standard Model prediction is observed. New lower limits are obtained for the black hole masses at the levels of 6.8 and 9.2 TeV in the Randall–Sundrum (RS) and Arkani–Dimopolous–Dvali (ADD) models, respectively [14] (Fig. 4).

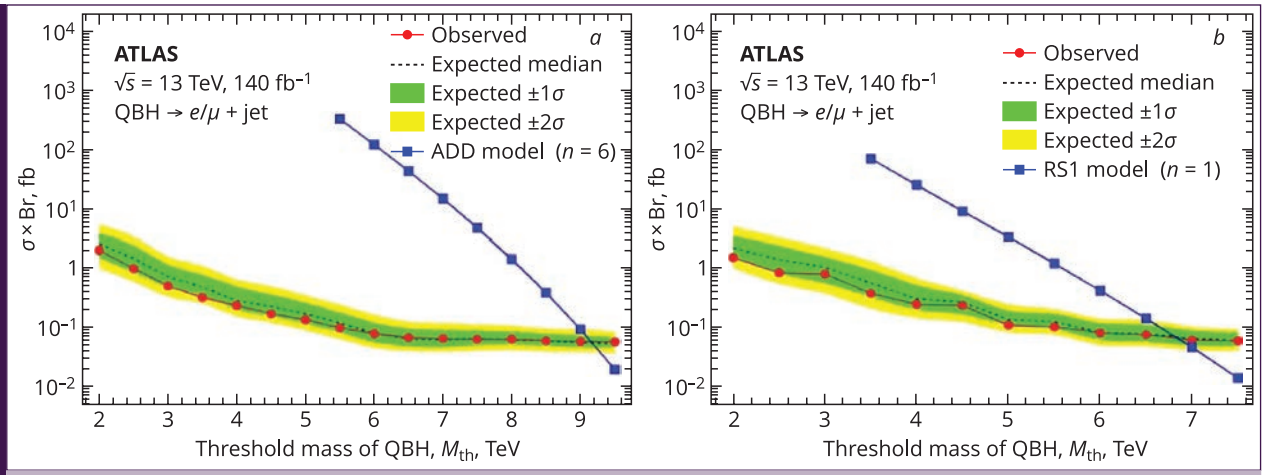


Fig. 4. New limits for the quantum black holes in the lepton + jet final states obtained in ADD (*a*) and RS (*b*) models

The ATLAS trigger software development was completed and trigger efficiencies were measured in Run 3 [15]. A contribution is made to the measurement of electron and photon reconstruction efficiencies in the ATLAS Run 2 data [16]. Work on supporting the ATLAS condition database, Event Picking service, and other software continues.

In 2024, the JINR **BESIII** group measured the prompt inclusive J/ψ and $\psi(3686)$ production cross section at collision energies from 3.808 to 4.951 GeV. In the analysis, the first measurement of the inclusive production of J/ψ and $\psi(3868)$ in the specified energy range is obtained, which is of the considerable interest in connection with the observation of charmonium-like states in a number of exclusive channels at these energies. The work underwent internal reviewing, during which an additional final state was included and systematic errors were redetermined [17].

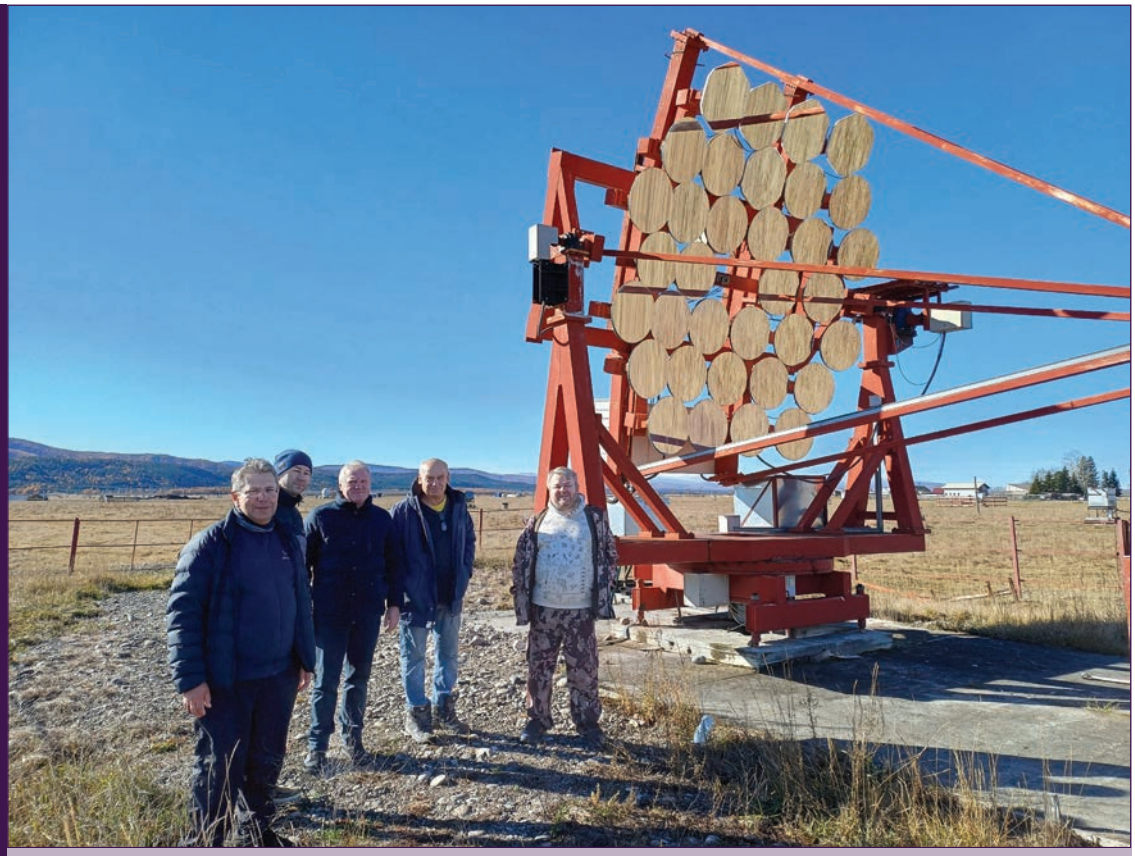
The JINR group within the **AMBER** experiment took part in the data taking, where they fully fulfilled their obligations related to participating in shifts at the experimental setup and maintaining normal operation of its subsystems. After the run, routine maintenance of the elements of the muon identification system was performed. A proposal to study the parton structure of charged kaons in the inclusive production of prompt photons with a high transverse momentum was prepared by the JINR group. A one-year run with positive and negative hadron beams with the energy of 190 GeV will allow accumulating statistics of 20 000 events of production of prompt photons with $p_T > 3$ GeV/c for kaons of each sign. This will enable one to measure the differential cross section in the range $0.4 < x_F < 0.5$ with an accuracy of 15–20% and separate the contributions of valence quarks and gluons.

Assembly and testing of two straw tracker stations of the **COMET** Phase I experiment has been completed at J-PARC (Tokai, Japan). Additional mass production of 10-mm-diameter straws for the 4th and 5th modules began. At this stage, it is planned to produce and test 500 new straws and deliver them to Japan. At the same time, straw tubes of a new design with a diameter of 5 mm were manufactured [18].

DLNP employees manufactured the first module in accordance with the design of the left wall of the COMET facility. The module was delivered to J-PARC. In April and November 2024, during a scheduled visit to J-PARC, DLNP employees completed preparation of the module for long-term statistics collection in space using a 32-channel FEB Meteor board provided by colleagues from the COMET Collaboration. The results of the studies led to the conclusion that FEB Meteor could not be used to determine the efficiency of the COMET experiment veto system module. To evaluate the efficiency of the module in the laboratory conditions, a factory-made CAEN DT5702 board would be enough. However, for the purpose of the experiment, it is necessary to develop radiation-resistant front-end electronics [19, 20].

The development of experimental equipment for the **TAIGA** project continues, in particular, light-pro-

Before the start of work on irradiating scintillator samples. From left to right:
E. Mustafayev (IRP), V. Baranov (DLNP), I. Vasiliev (DLNP), and M. Mirzayev (FLNR&IRP)



At the TAIGA experimental site in the Tunka Valley.
From left to right: DLNP Director E. Yakushev, DLNP SEDNS and RCh Head S. Rozov, Chief Engineer of DLNP S. Yakovenko, Dean of the Faculty of Physics at ISU N. Budnev, and Director of the Irkutsk NIIPF A. Tanaev

tective shades have been developed and tested on one of the Cherenkov telescopes, which made it possible to reduce the background by 10%. The JINR group is responsible for the manufacture and maintenance of the Cherenkov telescopes, modelling of the experiment detectors and regular expansion of the data bank obtained by the Monte Carlo method. As part of international cooperation, planned R&D has been carried out to develop and manufacture a photodetector consisting of a matrix of silicon photomultipliers and electronics and to manufacture the mechanical structure of the telescope.

APPLIED RESEARCH AND ACCELERATOR PHYSICS

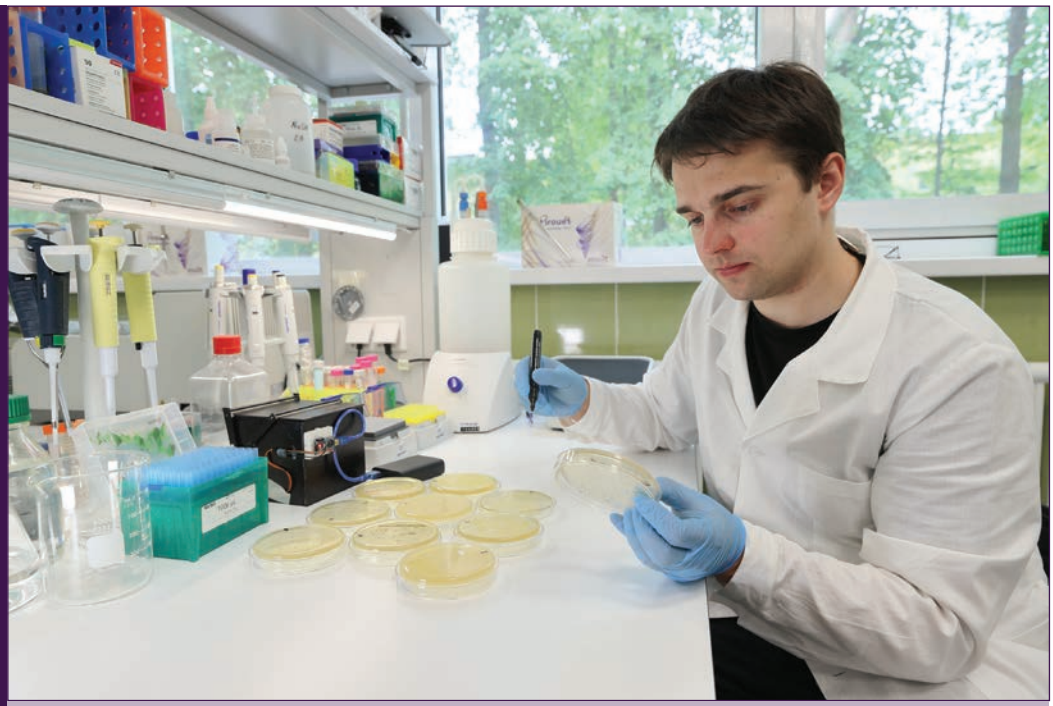
Within the project **"Radiochemistry and Spectroscopy for Astrophysics and Nuclear Medicine"**, the method of $^{132/135}$La isolation from barium target material has been developed for nuclear medicine purposes. The method provides a high radiochemical yield of (98 ± 2)% for the final product suitable for synthesis of radiopharmaceuticals [21].

In 2024, within the **PAS** project, by using the DBAL (Doppler Broadening of the Annihilation Line) method on the positron flux, more than 80 samples from the Russian scientific institutes (TPU and SAFU) and from the JINR Member States (Azerbaijan, Belarus, and Vietnam) were studied. For the first time, studies using DBAL coincidence on the positron flux were carried out at the installation and six samples were measured. More than 50 samples were studied using the method of measuring the lifetime of positrons in matter at an autonomous source.

Nanoscale multilayer coatings (NMCs) of Zr/Nb are promising materials for the reactor zone of new-generation reactors. The effect of self-healing of these materials was explained due to the experiments conducted by the DBAL method on a stream of positrons with variable energy of NMC samples from Zr/Nb. This series of studies is carried out for Tomsk Polytechnic University (TPU).

By using positron spectroscopy methods in collaboration with colleagues from Azerbaijan, it was shown that tungsten carbide (WC) samples exhibit greater plasticity in response to an increase in the gamma radiation dose. In addition, the operational limits of tungsten exposed to gamma radiation

19 April. Visit to JINR by Deputy Directors of the Cuban Isotope Centre (CENTIS) R. A. Serra Aguila and J. C. Cruz Arencibia. On tour of the DLNP Medical-Technical Complex



Genetic studies of extremely radioresistant organisms at the DLNP Sector of Molecular Genetics of the Cell

were evaluated and a functional threshold of up to 3.378 MGy was determined [22–26].

Scientists of the **DLNP Sector of Molecular Genetics of the Cell** together with colleagues from FLNP, MIPT, and USF (USA) determined for the first time spatial characteristics of the radioprotective protein of tardigrades Dsup (damage suppressor), proved its belonging to disordered proteins and established formation of a fuzzy complex during the Dsup–DNA interaction. Of the data obtained, it is assumed that the Dsup protein may be involved in the organization of chromatin in the nucleus [27].

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FLEROV LABORATORY of NUCLEAR REACTIONS

OPERATION AND DEVELOPMENT OF THE FLNR ACCELERATOR COMPLEX (DRIBs-III)

As part of the FLNR accelerator complex development effort (DRIBs-III project) in 2024, work was done on the construction of novel and the upgrade and optimization of the existing accelerator facilities with a view to increasing beam intensity and improving the quality of ion beams of both stable and radioactive nuclides in the energy range from 5 to 50 MeV/nucleon. The project also aims to enhance the efficiency of experiments on the synthesis and study of the properties of new superheavy elements and to expand the experimental programme on the synthesis of rare exotic nuclei and on the study of reactions with beams of radioactive nuclides.

In accordance with the FLNR research programme, the DC-280 cyclotron of the Superheavy Element Factory (SHE Factory) provided over 4000 h of beam time in 2024 for experiments on the synthesis of superheavy elements and study of their chemical properties at the DGFRS-2 and GRAND setups. Long-term experiments with 6.0-pμA ^{48}Ca beams were conducted at the GRAND setup. Furthermore, experiments using the ^{50}Ti beam with an intensity of 2.0 pμA at the target were carried out employing DGFRS-2.

The optimal configuration of the DECRIS-PM ion source was experimentally investigated, with the

Participants in the work on the U-400M accelerator modernization

Dubna, December. Construction of a new experimental hall of the U-400R complex

aim of increasing beam intensity and reducing the consumption of feed material.

The upgrade of the U-400M cyclotron was completed. Upon the start-up of the cyclotron systems, the Blocking and Alarm System and the Auto Radiation Monitoring System, the adjustment and commissioning work with accelerated beams began. Accelerated ^{15}N beams with the energy $E = 51$ MeV/nucleon and ^{16}O, ^{20}Ne, ^{40}Ar and ^{132}Xe beams were produced. The experimental setups delivered secondary beams ^{6}He, ^{8}He, and ^{12}Be, and the parameters of the primary and secondary beams were measured.

A wide variety of scientific and applied investigations in heavy-ion physics were conducted using the U-400 cyclotron that provided 5650 h of beam time for research in 2024. Experiments were carried out with the accelerated beams of ^{7}Li, ^{48}Ca, ^{86}Kr (MAVR setup), ^{40}Ca, ^{42}Ca, ^{44}Ca, ^{48}Ca, ^{48,50}Ti, ^{124,132}Xe (CORSET), and ^{54}Cr (SHELS). Applied studies with Ne, Ar, Kr, Xe and Bi beams were performed.

The electron accelerator, MT-25 microtron, ran for 962 h. The facility was employed to irradiate samples for the LRB JINR experiments carried out in collaboration with Vietnamese colleagues. The electron components were tested in cooperation with SPE Detector LLC and NIIKP. In a joint effort with DLNP and Tomsk State University, work to develop techniques for measuring electron energies and electron beam parameters was undertaken.

As part of the DC-140 project for applied research, renovation of experimental halls and assembly of the facility equipment are underway. Already complete is the construction of monolithic walls and concrete shielding blocks in the cyclotron hall and the experiment control room. The ventilation and gas purification system was mounted. Parallel to the mounting of the cooling system, preparations are well advanced for installation of the cyclotron equipment, the components of transportation channels and irradiation stations. The bench testing of the DECRIS-5M ion source was completed [1].

Furthermore, the construction of the new U-400R experimental hall has continued. In 2024, a total of 9100 m^3 of concrete was poured on site. As a major milestone, monolithic concrete work is 98% complete. Monolithic walls were constructed to form the building superstructure.

SYNTHESIS AND PROPERTIES OF SUPERHEAVY ELEMENTS

Production Cross Sections of Superheavy Elements in ^{50}Ti- and ^{54}Cr-Induced Reactions

The studies conducted in 2024 at the SHE Factory were aimed at measuring and comparing the cross sections of complete fusion reactions leading to the formation of one and the same superheavy nucleus when changing the projectiles from ^{48}Ca to ^{50}Ti and ^{54}Cr. Owing to very similar survival probability of the excited nucleus in this case, the difference in the reaction cross sections may be primarily attributed to the difference in the formation probability of the compound nucleus, the least studied feature of fusion–evaporation reactions. The ^{238}U + ^{54}Cr and ^{242}Pu + ^{50}Ti reactions, leading to the ^{292}Lv compound nucleus, were thereby chosen.

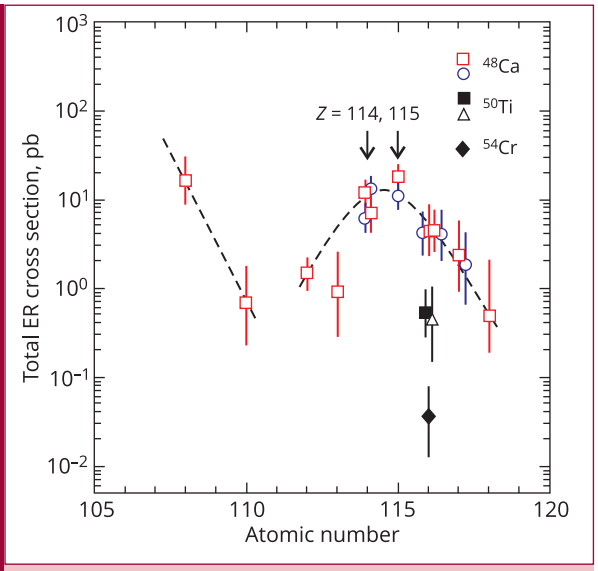


Fig. 1. The maximum cross section of the ^{48}Ca reactions with ^{226}Ra – ^{249}Cf nuclei. Red squares indicate the results obtained at FLNR; closed symbols are the results of experiments 2024; an open triangle is the cross section for the ^{244}Pu(^{50}Ti, 4*n*)^{290}Lv reaction measured in Berkeley (USA)

The reactions under consideration were studied using the gas-filled recoil DGFRS-2 separator of the SHE Factory. The cross sections for the 3*n* and 4*n* channels of the ^{242}Pu + ^{50}Ti reaction at the excitation energy of ^{292}Lv $E^* = 41$ MeV were about 0.32 and 0.22 pb. The cross section of the 4*n*-evaporation channel measured in the ^{238}U + ^{54}Cr reaction, leading to the same compound nucleus, turned out to be 36 fb at the excitation energy $E^* = 42$ MeV, which is lower by a factor of about 15 than that for the ^{242}Pu + ^{50}Ti reaction (Fig. 1).

The cross sections for the ^{242}Pu + ^{50}Ti and ^{238}U + ^{54}Cr reactions were lower by a factor of about 8 and 120, respectively, than the maximum cross section of Lv nuclei produced in the ^{245}Cm + ^{48}Ca and ^{248}Cm + ^{48}Ca reactions. However, the cross sections for the reactions of ^{48}Ca, ^{50}Ti, and ^{54}Cr with the target nuclei of ^{244}Cm, ^{242}Pu, and ^{238}U at close excitation energies were lower by a factor of ~ 2–10 and ~ 30–150 when changing the projectiles from ^{48}Ca to ^{50}Ti and ^{54}Cr, respectively. Thus, the experiment provided for the first time convincing evidence that the reactions of ^{50}Ti with the isotopes of actinide elements are an order of magnitude more efficient in synthesizing new elements 119 and 120 than those involving ^{54}Cr projectiles.

Furthermore, three new isotopes were discovered: two α-decaying ^{288}Lv nuclei (four decay chains) at $E_\alpha = 11.08$ MeV and with a half-life $T_{1/2} = 2.0$ ms; ^{289}Lv (three decay chains) at $E_\alpha = 10.90$ MeV, $T_{1/2} = 2.4$ ms; and a granddaughter of ^{288}Lv — a spontaneously fissioning ^{280}Cn with a half-life $T_{1/2} = 10$ μs. The last isotope mentioned above was produced via the α decay of ^{284}Fl at $E_\alpha = 10.57$ MeV. Such decay of ^{284}Fl, which is more prone to spontaneous fission, was observed for the first time. The decay properties of these new nuclei correspond to the data expected with regard to both the systematics of α-decay energies and times and spontaneous fission times. The results are presented in [2–6].

Spectroscopy of Heavy and Superheavy Nuclei

In the first half of 2024, experiments conducted at the SHELS separator were aimed at studying the formation of complete fusion reaction products and the decay properties of nuclei in the transfermium region. In February, special attention was focused on the complete fusion reaction ^{40}Ar + ^{209}Bi leading to ^{246}Md produced in the 3*n* reaction channel. Alternative evaporation channels of the reaction, such as *pXn* and *αXn*, were analyzed, and the ^{246}Md delayed fission data (after electron capture) were verified. The SFiNX detection system was used for studying the spontaneous fission of the ^{260}Sg isotope produced in the ^{54}Cr + ^{207}Pb complete fusion reaction after the evaporation of one neutron. Data on neutron multiplicity from the spontaneous fission of this nucleus were obtained for the first time.

In addition, the SHELS separator was used for studying multinucleon transfer (MNT) reactions. For each of the experiments under consideration, optimal separator modes were selected for registering MNT reaction products. An overview of the experimental results is available in [7].

Commissioned in 2022, the gas-filled GRAND separator (DGFRS-3) was equipped with a new target chamber 480 mm in diameter (240 mm earlier) that was tested using the well-known ^{48}Ca + ^{206}Pb = 2*n* + ^{252}No reaction. In the focal plane of the GRAND separator, about three nobelium nuclei per second were registered at the projectile intensity of 6 pμA. Such experimental parameters afford expanding opportunities for thorough studies of the properties of heavy and superheavy nuclei.

Preparations have continued for studies of the superheavy element structure using the detection

The GRAND (DGFRS-3) separator and a beam-stopper protection assembly

system GABRIELA of the GRAND separator. A ^{242}Pu target (480-mm target chamber) will be used in the upcoming experiments that will be aimed at acquiring previously inaccessible spectrometric data on the α decay of the even–even ^{286}Fl nucleus. Several hundred α decays of the nucleus under study that can be recorded over a 60-day-long experiment could provide data on the lowest levels (0^+, 2^+) of the ground state transition of the ^{282}Ds nucleus. These data directly indicate the deformation degree of the studied nucleus, i.e., how far the nucleus is lying from the hypothetical region of spherical superheavy nuclei ("Island of Stability").

Chemistry of Transactinides

The work was completed on the upgrade of the Cryodetector setup designed for experiments on radiochemical separation of nuclear reaction products and on the study of the gas-phase adsorption of the short-lived isotopes of Cn and Fl at the SHE Factory. The stopping of ^{254}No recoil nuclei was for the first time studied in a mixture of inert gases, as a function of their ratio, in the ^{208}Pb(^{48}Ca, xn)$^{256-x}$No reaction at the gas-filled GRAND separator. The testing of the novel vacuum and cryogenic cooling systems performed at the upgraded setup showed that after equilibrium was established, fluctuations in gas composition and the temperature gradient were insignificant over a long time. Moreover, a model was developed for estimating speed and transport efficiency of ultra-short-lived radionuclides in the gas transport system.

Furthermore, *online* experiments conducted at the upgraded setup located behind the GRAND separator showed a record-breaking for this type of chambers transportation time of 200 ms and confirmed the increase in separation efficiency of volatile radioisotopes of mercury, including ^{178}Hg ($T_{1/2}$ = 256 ms), by over a factor of two. The capabilities of both the SHE Factory and the upgraded setup enable detailed studies of the chemical properties of Cn and Fl at a novel statistics level. An experiment is prepared on gas adsorption thermochromatography of Cn and Fl, synthesized in the ^{242}Pu(^{48}Ca, 3n)^{287}Fl reaction, on a gold surface.

Additionally, combined quantum chemical and molecular dynamics calculations were made with a view to estimating the diffusion coefficients of heavy and superheavy atoms in the gas phase. On the basis of these calculations, the diffusion coefficients of the Fl atom in the Ar gas phase at varying temperatures were measured for the first time. The obtained data will aid in pursuing the modeling of the chromatographic process using the Monte Carlo simulation.

Written in collaboration with scientists from FLNR JINR, IMP (China), and PSI (Switzerland), the first article was published in 2024 on developing the LEGEND setup for studying the chemical properties of Nh at the upgraded accelerator complex HIRFL in China [8]. At the end of 2024, the new setup finished its first run of gas adsorption thermochromatogra-

Dubna, 22 November. Visit to JINR by RAS President G. Krasnikov and RAS Vice-Presidents V. Panchenko and S. Kalmykov. On an excursion to FLNR

22 March. A delegation of the Ministry of Science, Technology and Environment of the Republic of Cuba (CITMA), headed by Deputy Minister A. Rodriguez Batista, on an excursion to the Laboratory

phy of ^{284}Nh produced by irradiating the ^{243}Am target with ^{48}Ca beams. The preliminary results corroborate FLNR pioneering research outcomes on the chemical identification of ^{284}Nh in the ^{288}Mc decay chain.

Another important area of investigation was the development of methods for synthesizing metal-organic compounds of ^{50}Ti and ^{54}Cr to produce accelerated ion beams from the ECR source by the MIVOC (Metal Ions from VOlatile Compounds) method during SHE synthesis. This research, essential to the synthesis of SHE, resulted in a highly purified ^{54}Cr$(C_5H_5)_2$ compound that was subsequently used in the fusion experiment involving ^{54}Cr and ^{238}U, leading a previously unknown isotope ^{288}Lv.

Dynamics of Heavy-Ion Interaction, Fission of Heavy and Superheavy Nuclei

In 2024, the capture cross sections and mass–energy distributions of binary fragments formed in the ^{40}Ar, ^{40}Ca, ^{44}Ca, ^{48}Ca, ^{48,50}Ti + ^{208}Pb reactions were measured at energies near and substantially lower the Coulomb barrier. The experimental efforts were aimed at studying in more detail the impact of the structure of nuclei near ^{48}Ca in cold fusion reactions on the capture of interacting nuclei and further evolution of the dinuclear system. On the basis of the analysis of mass and energy distributions, fusion–fission fragments were separated from quasifission fragments. The dynamics of the reaction mechanism was studied with allowance for the 2-neutron and 2-proton difference from the closed neutron and proton shells in the projectile nucleus.

The experiments were carried out at the U-400 accelerator of FLNR JINR using the double-arm time-of-flight CORSET spectrometer. Figure 2 shows the measured capture cross sections (CS) for the reactions.

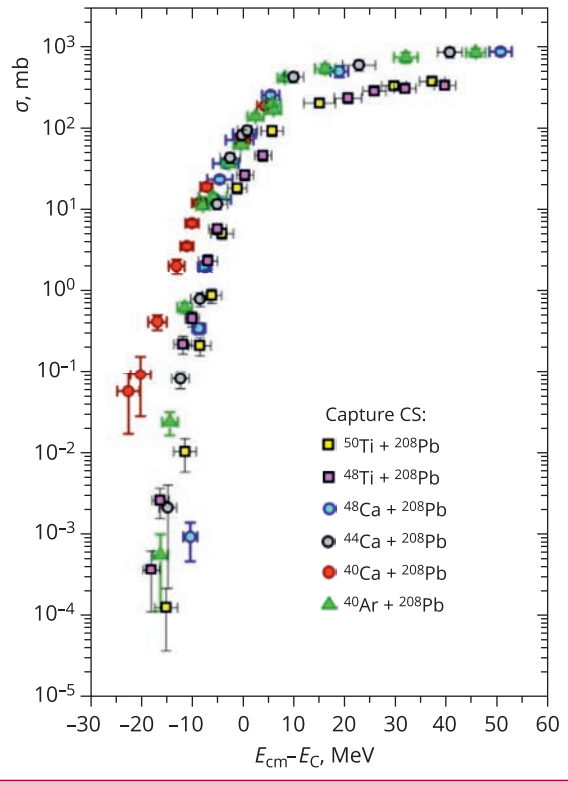
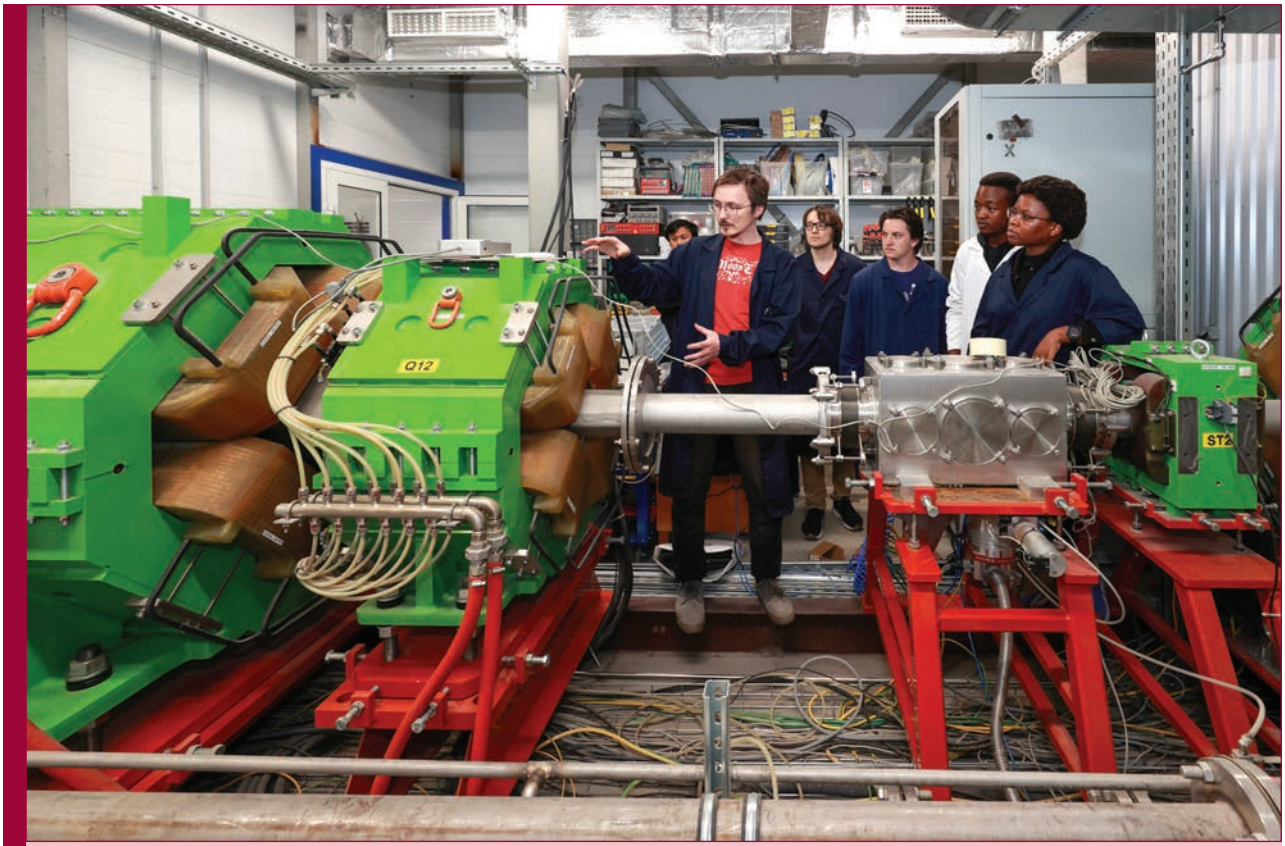


Fig. 2. The measured capture cross sections for the cold fusion reactions ^{40}Ar, ^{40,44,48}Ca, ^{48,50}Ti + ^{208}Pb

23 December. Academician Yu. Oganessian delivers
a report “Cold Fusion of Massive Nuclei” at the general laboratory seminar



18 June. Excursion to the ACCULINNA-2 facility for students from RSA participating
in the International Student Practice in JINR Fields of Research

In 2024, experimental data were processed and analyzed on the detailed studies of the properties of multinucleon transfer (MNT) reaction fragments formed in the ^{136}Xe, ^{209}Bi + ^{238}U experiments at interaction energies 40–50% above the Coulomb barrier. The research was carried out in 2023 at the upgraded CORSET spectrometer using two experimental techniques: two-arm time-of-flight (ToF–ToF) measurements for studying two-body coincidences and correlated three-arm time-of-flight and energy measurements (ToF–E) for studying three-body coincidences. The primary and secondary mass and energy distributions of projectile-like fragments (PLF) were formed in coincidence with either survived target-like fragments (TLF) or with both fragments of sequential fission of excited TLF. It was found that in both reactions, MNT fragments heavier than ~ 250 a.m.u. mainly undergo fission. The heaviest primary fragments registered in three-body coincidences in the ^{136}Xe + ^{238}U reaction have a mass of ~ 265 a.m.u. ($Z \approx 103$), meanwhile those observed in the ^{209}Bi + ^{238}U reaction have a mass of 289 a.m.u. ($Z \approx 113$). The cross section of the survived fragments with masses over 250 a.m.u. is about an order of magnitude higher in the reaction with ^{209}Bi ions. The results obtained in the ^{136}Xe + ^{238}U reaction were published in 2024 [9], and those of the ^{209}Bi + ^{238}U experiment will be presented in the article that is now being written.

Structure of Exotic Nuclei

The most important results of the ACCULINNA group in 2024 were the completion of data analysis on previously conducted experiments employing the ACCULINNA-2 complex at the U-400M heavy-ion cyclotron [10, 11] and further advances in the methodology and experimental techniques [12]. Of special interest are two investigations described below.

The ^{7}He system was studied in the ^{2}H(^{6}He, ^{1}H)^{7}He reaction at the ^{6}He beam energy of 29 MeV/nucleon [10]. A theoretical data analysis was conducted using the PWIA (Plane-Wave Impulse Approximation) calculation. It was found that three partial amplitudes $p_{3/2}$, $p_{1/2}$, and $s_{1/2}$ and phase shifts calculated using the Azure2 code could reproduce the low-energy ^{7}He spectrum below the excitation energy of 8 MeV. The positive-parity s wave can be used for describing the forward-backward asymmetry in neutron emission in the ^{7}He centre-of-mass system with respect to the direction of the momentum transferred in the reaction. Within the pole mechanism for the ^{2}H(^{6}He, ^{1}H)^{7}He reaction, this points to the interference of the waves of different parity during the formation of a continuous spectrum at $E(^{7}\text{He}) < 8$ MeV.

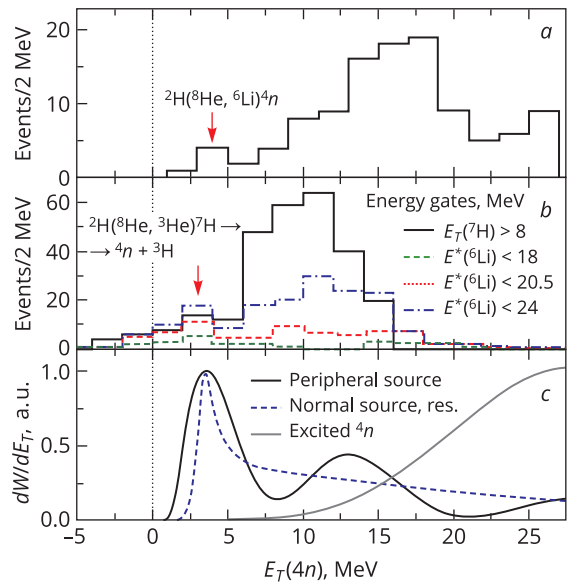


Fig. 3. The comparison of experimental data (*a*, *b*) and theoretical results (*c*) for the transferred momentum $q_\alpha = 250$ MeV/c assuming that the reaction mechanism is extremely peripheral (a black curve)

Furthermore, experimental data obtained in the ^{2}H(^{8}He, ^{6}Li)^{4}n and ^{2}H(^{8}He, ^{3}He)^{7}H → ^{3}H + 4n reactions were analyzed at the ^{8}He beam energy of 26 MeV/nucleon. A tetraneutron system was studied as a low-lying resonant state at an energy of about 3.5 MeV [11]. The theoretical interpretation of the observed 4n spectrum using the hyperspherical harmonics model points to the extreme peripheral character of the process and to the fact that the observed hump is ascribed to the ^{8}He wave function states with a hypermomentum $K = 2$. The resonance position within the $E_T(4n) \sim 3$–5 MeV range (Fig. 3) was shown to be stable only in the case of a strong peripheral reaction mechanism with specific neutron correlations in the ^{8}He source and for the range of transferred momenta $q_\alpha \sim 150$–350 MeV/c.

CONSTRUCTION OF NEW AND DEVELOPMENT OF EXISTING EXPERIMENTAL SETUPS

Complex for Measuring Masses of Superheavy Nuclei

The complex for precision measurement of the masses of superheavy nuclei is developed for the SHE Factory and comprises a cryogenic gas catcher and a multireflection time-of-flight mass spectrometer. Work on the construction of the cryogenic gas ion catcher continued in 2024.

- Tests were performed with an internal open-type ^{223}Ra alpha source emitting daughter nuclei that are, in turn, alpha-radioactive. Separation efficien-

cy of 35% was attained at room temperature when the ^{119}Rn alpha decay was registered at the RF transport system exit.

- Methodology was developed for testing the efficiency and separation time of the gas catcher at the cryogenic temperature (40 K).
- Studies have continued with complete fusion reaction products on simulation of the efficiency and extraction time from the cryogenic gas ion cell. Software programmes based on the SRIM2013, Geant4, Root, SIMION, and COMSOL software packages were developed with a view to defining the optimal conditions for stopping reaction products in the gas cell. The work is in its final stage.

In collaboration with the Institute for Analytical Instrumentation of RAS (Saint Petersburg), work continued on designing the multireflection time-of-flight mass spectrometer for precision measurements of the masses of the isotopes of heavy and superheavy nuclei. The construction documentation for the time-of-flight mass analyzer was prepared. To study the possibilities of using ionized fullerene fragments as calibration ions, a test bench was developed whose key element is an ion source with electron ionization. Further, a contract was concluded for the manufacture of a unique quadrupole mass spectrometer, which is a prototype of a mass filter for the multireflection time-of-flight mass spectrometer. Purchase agreements were prepared for the main serial production equipment.

RADIATION EFFECTS AND PHYSICAL BASES OF NANOTECHNOLOGY, RADIOANALYTICAL AND RADIOISOTOPE INVESTIGATIONS AT FLNR ACCELERATORS

The microstructure of the AlN/Al_2O_3, CeO_2/ZrO_2:Y, Si/Al_2O_3 interface layers irradiated with xenon (160 MeV) and bismuth (670 MeV) ions in the non-overlapping track mode was studied using the high-resolution transmission electron microscopy. Latent tracks and hillock-like defects at the Si/Al_2O_3 layer boundaries were found to be formed in aluminum oxide and zirconium oxide crystals.

Quite as significant was the study of the formation of radiation defects and helium porosity in stainless steel samples doped with 3-MeV helium ions at the Tandetron accelerator (iThemba LABS, RSA). The developed technique was shown to allow for a homogeneous profile of implanted helium at depths up to 3 μm. The pore size and pore density were defined as a function of post-radiation annealing temperature.

Furthermore, a number of ferritic ODS alloys irradiated with high-energy xenon (150 MeV) and bismuth (670 MeV) ions underwent micromechanical testing using nanoindentation. It was shown that amorphization of oxide nanoparticles during ion track overlapping did not lead to changes in radiation hardening. The results are presented in [13].

Inasmuch as low-reagent content poses challenges in separating monovalent cations, primarily

FLNR Nanocentre

Studies of suppression of virus activity on track membranes modified with polyethylenimine, silver nanoparticles, and curcumin

lithium cations, the use of nanoporous track-etched membranes in electro-baromembrane process was studied. Application of electric and pressure fields, two opposite forces, in a 35-nm track-etched membrane allowed separation of Li^+ ions from sodium and potassium ions in natural and technogenic brines [14].

Further, nanoporous track-etched membranes were shown to be good templates for manufacturing flexible heating elements that can be used in medical devices for temperature control and as thermal barrier coatings in technological applications [15].

The ion-track technology was crucial for developing polycarbonate and polypropylene based nano- and microtextures. Owing to contact angles, the surface exhibits anisotropic hydrophobic properties. The developed materials are extremely promising in the manufacture of water-resistant coatings and surfaces with self-cleaning properties [16].

Additionally, a method was developed for fabrication of hybrid membranes comprising a microporous substrate covered with a thin layer of titanium and a hydrophobic polyvinylidene fluoride nanofiber layer deposited by electrospinning. Hybrid track membranes were shown to be effective in water desalination by membrane distillation. The salt rejection coefficient amounted to 99.97–99.98% [17].

Important were studies of the impact of the ion mass and energy on the structural and chemical changes in polyvinylidene fluoride (PVDF) under swift-heavy-ion irradiation. A method was developed for radiation-induced graft polymerization of functional monomers in ion tracks and nanopores of PVDF track membranes with a view to developing proton-conducting membranes promising for hydrogen energy applications.

Composite track-etched membranes with gold and silver nanolayers deposited by magnetron and thermal sputtering were fabricated. These membranes were shown to be promising for the use in flow biosensors for the detection of the influenza A virus.

Moreover, track-etched membranes modified with polyethylenimine, silver nanoparticles, and curcumin were used for studying filtration of viral suspensions and were found to be highly efficient in inhibiting the activity of the herpes and stomatitis viruses [18].

The adsorption capacity of track-etched membranes functionalized with DNA-binding Dsup protein was investigated. The filtration experiments verified the ability of track-etched membranes with the immobilized Dsup protein to absorb cell-free DNA at an accumulation capacity of (70 ± 19) mg/m^2 [19].

Finally, a preparative tangential flow filtration system was developed, which allows extraction of low-molecular-weight substances from samples containing cellular exosomes.

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FRANK LABORATORY of NEUTRON PHYSICS

In 2024, the scientific programme of the Frank Laboratory of Neutron Physics (FLNP) was aimed at obtaining new results within the framework of projects and subprojects of the JINR Plan for Scientific Research and International Scientific and Technical Cooperation: in condensed matter physics ("Pulsed neutron source and complex of spectrometers", 04-4-1149-2024/2028, leader — E. V. Lychagin; "Investigations of functional materials and nanosystems using neutron scattering", 04-4-1149-2-2021/2028, leaders — D. P. Kozlenko, V. L. Aksenov, and A. M. Balagurov; "Optical methods in condensed matter studies", 04-4-1147-2024, leaders — G. M. Arzumanyan and N. Kucerka); in neutron nuclear physics ("Neutron nuclear physics", 03-4-1146-2024, leaders — Yu. N. Kopach, P. V. Sedyshev, and V. N. Shvetsov); in the development of the FLNP basic facilities ("Development of the IBR-2 facility with a complex of cryogenic moderators", 04-4-1149-1-2011/2028, leaders — A. V. Vinogradov and A. V. Dolgikh); in the development of the IBR-2 spectrometers and computation complex ("Scientific and methodological research and developments for condensed matter investigations with IBR-2 neutron beams", 04-4-1149-3-2021/2028, leaders — V. I. Bodnarchuk and V. I. Prikhodko); in the development of the design of the new neutron source ("New advanced neutron source at JINR", 04-4-1149-4-2021/2028, leaders — E. V. Lychagin, V. N. Shvetsov, and M. V. Bulavin).

Dubna, 15 March. Seminar dedicated to the 40th anniversary of the IBR-2 reactor commissioning

Structure Investigations of Novel Oxide, Intermetallic and Nanostructured Materials

Investigations of quasi-two-dimensional layered van der Waals magnetic materials of the MPS_3 family (M is a transition metal) were continued. The crystal, magnetic structure and vibrational spectra of the $MnPS_3$ compound were studied using neutron diffraction in the pressure range up to 3.6 GPa and temperatures of 15–300 K, as well as X-ray diffraction and Raman spectroscopy at high pressures up to 28 GPa and room temperature [1]. At pressures above 1 GPa, an isostructural phase transition to a new phase of monoclinic *C*2/*m* symmetry was observed, accompanied by abrupt shortening of lattice parameters, significant reduction of the monoclinic distortion, and anomalies in the pressure behavior of a number of vibrational modes (Fig. 1). At the same time, the symmetry of the antiferromagnetic (AFM) structure remains unchanged throughout the entire studied pressure range. The change in the nearest-neighbor exchange interaction parameter under high pressure was evaluated. The observed stability of the magnetic order in $MnPS_3$ is very different from the behavior of $FePS_3$, where a similar structural phase transition also causes a change in the symmetry of the magnetic ordering under pressure. Based on the analysis of competing interplane and in-plane magnetic exchange interactions, a model is proposed that explains the different behavior of the magnetic states of these compounds under pressure.

Layered perovskite-like titanates with the general formula $A_2Ti_2O_7$ (A = La, Ce, Pr or Nd) possess one of the maximum Curie temperatures for the occurrence of ferroelectricity, pronounced piezoelectric and ferroelectric properties, and excellent dielectric permittivity characteristics. They also exhibit high anisotropy of electrical conductivity at low temperatures, which makes layered perovskite-like titanates very promising materials as quasi-one-dimensional metals. The unusual physical properties of perovskite-like titanates are due to the peculiarities of their crystal structure — the so-called Carpy–Galy phase, in which the oxygen octahedra TiO_6 form distorted crystalline layers separated from each other by topologically distorted planes of rare-earth elements. It is assumed that the mutual orientation of oxygen octahedra in the crystal structure of layered perovskite-like materials plays a significant role in the formation of their ferroelectric properties. At present, the influence of thermodynamic parameters (high pressure, temperature) on the crystal structure and physical properties of $A_2Ti_2O_7$ titanates remains insufficiently studied. Studies of the structural behavior of these compounds under high pressure are of great importance for establishing the relationship between structural parameters and physical properties, as well as for searching for new structural modifications of these materials, the properties of which may differ significantly from the original ones. Systematic studies of the crystal structure and vibrational spectra of layered perovskite-like titanates $La_2Ti_2O_7$, $Nd_2Ti_2O_7$, and $Pr_2Ti_2O_7$ [2] were performed at high pressures up to 30 GPa using neutron diffraction, X-ray diffraction and Raman spectroscopy. In all studied perovskite-like titanates $La_2Ti_2O_7$, $Nd_2Ti_2O_7$, and $Pr_2Ti_2O_7$ at high pressures above 15 GPa, a structural phase transition was detected, which is accompanied by anomalies in the baric dependences of both the crystal structure parameters and the vibrational modes of these compounds. A detailed analysis of the experimental data

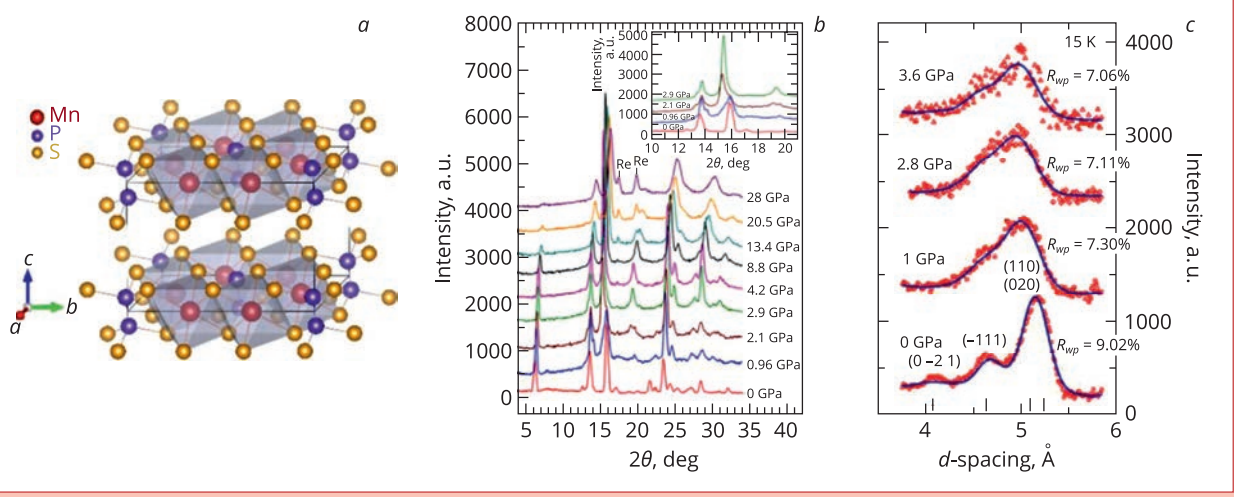


Fig. 1. Monoclinic crystal structure of $MnPS_3$ (*a*), X-ray diffraction patterns at different pressures illustrating the structural phase transition (*b*), magnetic contribution to the neutron diffraction patterns at different pressures and T = 15 K (experimental points) and the results of calculations using the Rietveld method (solid lines) (*c*)

Beijing (China), 4 February. Yu. Gledenov, a Senior Researcher at FLNP JINR, was awarded the Friendship Prize.
Photo: © *https://english.www.gov.cn/*

indicates a change in the symmetry of the monoclinic crystal structure of perovskite-like titanates from the space group $P2_1$ to $P2/m$ at high pressure. On the basis of the obtained experimental data, a general structural mechanism of the pressure-induced phase transition in perovskite-like layered titanates was proposed. It was shown that the degree of disorder of the titanium layer, which changes during the phase transition due to a change in the orientation of the oxygen octahedra relative to the crystallographic axes, is an important parameter controlling the properties of layered titanates, and its increase leads to the suppression of the ferroelectric state in the studied titanates at high pressure.

Studies of Fe–Ga alloys with giant magnetostriction were continued. A series of $Fe_{73}Ga_{27}$ samples were studied using synchrotron diffraction at the BM01A and ID28 beamlines (ESRF) in the mode of continuous heating (up to 950°C) and subsequent cooling to room temperature, as well as at some fixed temperatures [3]. Previous studies have shown that in the measured cross sections of the reciprocal space of the $Fe_{73}Ga_{27}$ single crystal, many additional reflections are observed that do not belong to the crystal lattice of the main phase $D0_3$, but to some new phase (hereinafter the *X* phase) with a large unit cell. Additional measurements of electron diffraction patterns (Fig. 2) confirmed the presence of this phase in the sample. It follows from the analysis that the *X* phase can be described in hexagonal syngony with parameters a = 8.291 Å, c = 10.143 Å. Formally, all observed reflections of this phase can be attributed to a cubic lattice with a tripled $D0_3$ phase parameter, namely, with $a = 3a(D0_3) \approx 17.34$ Å. The symmetry of the *X* phase is not yet reliably known, although it can be assumed that it somehow corresponds to the structure of the $B8_2$ phase of the Fe_3Ga alloy. The basis for this assumption is the coincidence of the syngonies and the good correspondence of the refined values of the lattice parameters of the *X* phase to the doubled parameters of $B8_2$ ($a \approx 4.03$ Å, $c \approx 5.03$ Å). To determine the structure of the *X* phase, it is necessary to increase its content in the alloy, which can be facilitated by correctly selected temperature conditions. Due to the discovered proportionality of the unit cells of $D0_3$ and *X* phases, it turns out that the reflections of the *X* phase imitate the possible presence of superstructure reflections of the tetragonal $L6_0$ phase. It is known that it is the formation of the $L6_0$ phase in Fe–Ga alloys that is considered as the most likely reason for the

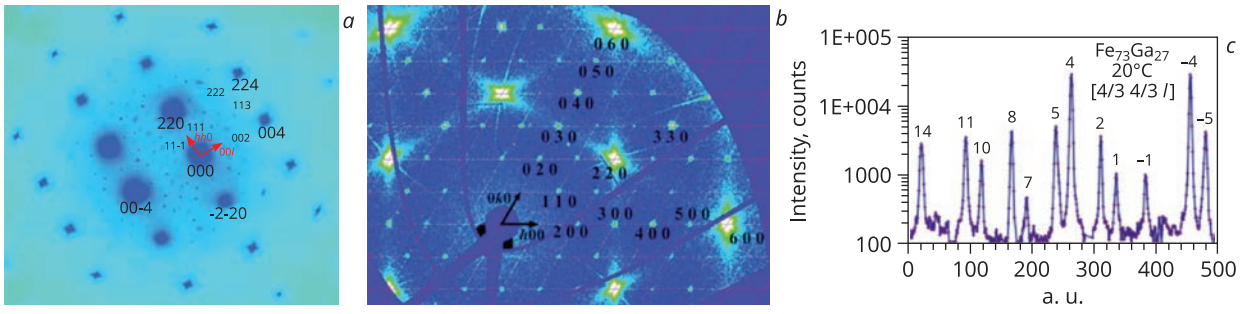


Fig. 2. *a*) TEM diffraction pattern of the $Fe_{73}Ga_{27}$ sample, *hhl* reciprocal space layer. Directions [*hh*0] and [00*l*] and the Miller indices of several fundamental (220, 004, 224, etc.) and superstructure (111, 002, 113, etc.) peaks of the $D0_3$ phase are indicated. Most reflections are related to the *X* phase. *b*) 2D layer of the reciprocal space of the $Fe_{73}Ga_{27}$ alloy at 20°C, ID28 station. The grid corresponds to a hexagonal lattice with parameters a = 8.291 Å, c = 10.143 Å, and cross section *hk*0. *c*) 1D scan in the direction [4/3 4/3 *l*] in the *hhl* layer of the $Fe_{73}Ga_{27}$ alloy at 20°C, ID28 station. The Miller indices are given for a primitive cubic cell with $a \approx 5.78$ Å

22 March. Visit to JINR by Vice-Minister of Science and Higher Education of the Republic of Kazakhstan D. Ahmed-Zaki (2nd from the left). On an excursion to the Laboratory

Dubna, 13–15 May. Participants of FLNP JINR – CSNS (China Spallation Neutron Source (Dongguan, China)) Workshop on the Neutron Scattering Technology and Multidisciplinary Research

enhanced magnetostriction in these alloys. A number of publications have reported the detection of reflections of the $L6_0$ phase in $Fe_{81}Ga_{19}$ and $Fe_{73}Ga_{27}$ in electron diffraction experiments. The obtained results suggest that, at least in $Fe_{73}Ga_{27}$ compositions, these could be reflections of the *X* phase.

Materials for Energy Storage and Conversion

The presence of a number of $Fe(CN)_6$ vacancies and structural water in the initial structure of sodium hexacyanoferrate (Prussian white (PW), a cath-

ode material for sodium-ion batteries) affects the stability of the crystal lattice during electrochemical cycling and leads to a drop in capacity after long-term operation. Several studies have shown that coating hexacyanoferrate powder with polyaniline leads to the formation of a protective layer that prevents degradation of the material and, as a consequence, to more stable electrochemical cycling of the cathode based on Prussian blue analogues. Using X-ray diffraction and synchrotron radiation, SEM, TGA and IR spectroscopy, the effect of coating PW powder with a polyaniline layer on the structure, phase transitions during heating and charge–discharge processes was studied. The process of coating with polyaniline (PANI) involves dispersion of the initial powder in a 0.01M hydrochloric acid solution, which leads to the formation of a sodium-deficient cubic phase due to the release of sodium from the hexacyanoferrate structure both in the presence of aniline (during synthesis on PW particles of the PANI shell) and without aniline (control sample after dissolution in hydrochloric acid — PW_HCl). The phase transition characteristic of PW from the cubic phase to the dehydrated rhombohedral phase upon heating of the PW@PANI material shifts towards higher temperatures compared to the initial PW powder and the powder kept in acid but without the polyaniline coating, which indicates that the polyaniline layer prevents the release of water from the sodium hexacyanoferrate structure. This is also evidenced by the longer (compared to the PW electrode) existence of the hydrated rhombohedral phase during charge–discharge of the PW@PANI electrode.

Investigation of Biological Nanosystems, Lipid Membranes and Lipid Complexes

The accumulation of amyloid-beta peptides (Aβ) in brain tissue is considered one of the possible causes of the onset and progression of Alzheimer's disease. Therefore, the structural features of the interaction of Aβ with the lipid membrane in systems simulating the preclinical stage of the disease, as well as the effect of biologically significant molecules on these systems, are being studied.

Using small-angle neutron scattering and X-ray methods, a critical concentration of Aβ peptides was revealed, above which disruption of the lipid membrane and morphological reorganization of lipid objects are observed, which is manifested in a change in their supramolecular structure (vesicles–disc-shaped objects) [4]. It was shown that calcium ions counteract the effect of Aβ peptides on the structure of the lipid membrane, but do not affect the membrane disruption induced by the peptide. It was found that the supramolecular structural organization of lipid objects remains unaltered upon the addition of calcium ions.

Studies of the structural mechanisms of lipid-peptide interactions were supplemented by the results from Raman scattering spectroscopy, molecular dynamics (MD) and density functional theory (DFT) simulations to reveal conformational transformations of Aβ [5]. The research findings showed that the secondary structure of Aβ in liposomes is dominated by the time-stable α-helix conformation. However, it was unexpected to find that the lipodisc environment induces the transformation of the Aβ42 secondary structure into a β-turn/random coil. The results of the Raman study have shown that Aβ42 peptides presented in liposomes maintain their native form, unlike lipodiscs. These experimental findings were confirmed by MD and DFT simulations, the results of which are presented in detail in the published paper.

So, the combination of small-angle neutron scattering and X-ray, MD, DFT and Raman scattering studies is a promising and reliable approach for a more comprehensive understanding of physicochemical processes occurring in living organisms, the understanding of which is necessary to unravel the mechanisms of the neurotoxic effects of the peptides, and consequently, to find ways to treat Alzheimer's disease.

Investigation of Polymer Materials and Films

Studies continued on polyacrylamide brushes on a planar surface, synthesized by the "grafting through" method with regulation of the thickness and grafting density by varying the polymerization temperature [6]. The scalability of the synthesis of polymer brushes on Si and SiO_2 crystals with a large surface area (5 × 9 cm) was considered. To conduct polymerization on these crystals under sealed conditions at a constant temperature, a special cell was designed and manufactured. The chemical structure of polyacrylamide brushes synthesized at different temperatures (30–60 °C) was analyzed using XPS and IR spectroscopy. Comparison of the structure of chemically grafted brushes ("grafting through" method) and physically adsorbed films (spin-coating) of polyacrylamide was performed using reflectometry and IR spectroscopy. It was found that there was strong interaction between the polymer chains in the brush, in contrast to the dense layer of polyacrylamide. The homogeneity of the brush thickness (~ 20 nm) across the surface was analyzed using X-ray reflectometry. The relatively high density and simplicity of the "grafting through" method make it promising for the development of special coatings both for industrial applications (antibacterial coatings) and for research purposes, in particular, for single-molecule microscopy, which requires dense and chemically inert polymer brushes. The method is also easily scalable to larger substrates due to its resistance to external conditions and lower cost compared to other methods of grafting polymers to a surface.

Atomic and Molecular Dynamics

The synthesis of a new compound from a series of structural analogues of thyronamines (4-[4-(2-aminoethoxy)benzyl]aniline) was realized by researchers from the NERA group [7]. The structure of the obtained thyronamine was confirmed by NMR, IR and Raman spectroscopy. Using the DFT approximation (B3LYP/6-31G(*d*, *p*) level of theory), the intramolecular dynamics of 4-[4-(2-aminoethoxy)benzyl] aniline (TAM) was studied taking into account nonspecific solvation with dimethyl sulfoxide (DMSO), as well as optimization of the molecular geometry and calculation of the parameters of the electronic structure of the protonated forms of TAM were performed. For the most stable conformer of the studied thyronamine, associative interactions with DMSO were studied. For solvates of 4-[4-(2-aminoethoxy)benzyl]aniline with one and two DMSO molecules, the magnetic shielding constants were calculated and the chemical shifts of the ^{1}H and ^{13}C nuclei were estimated. The effect of TAM on the main indices of lipid peroxidation (LPO) was studied in a model of acute cerebral ischemia. It was found that the studied synthetic analogue of thyronamine TAM has great potential in terms of activation of antioxidant protection mechanisms in the cerebral cortex of white laboratory rats under conditions of acute hemispheric ischemia.

Applied Research

Oxide dispersion-strengthened (ODS) alloys and steels are among the most promising nanostructured structural materials with a wide range of technological applications. Nanooxide inclusions dispersed in metal matrices make it possible to achieve significantly higher thermal stability, creep resistance at high temperatures, and radiation resistance. Therefore, ODS alloys are widely used in turbine manufacturing technologies and nuclear power engineering, in particular, as structural materials for advanced nuclear power plants, fast neutron reactors, future thermonuclear reactors, etc. The special properties of ODS alloys are largely determined by the structural characteristics of nanoinclusions. A complex structural study of ODS steels of grades Eurofer ODS and 13.5Cr–Fe_3Y ODS developed at the Karlsruhe Institute of Technology (Germany), and KP-4 ODS from Kyoto University (Japan) was conducted using SANS, TEM and APT [8]. These ODS steels were produced by mechanical alloying of metal powders and oxide powders and were ferritic martensitic steels and ferromagnetic materials. According to TEM results, the average size of small oxide particles was (6 ± 2) nm for Eurofer ODS, (5 ± 2) nm for KP-4 ODS, and (6 ± 1) nm for 13.5Cr–Fe_3Y ODS, with the particle number densities of $(4 \pm 1) \cdot 10^{22}$ m^{-3}, $(2 \pm 1) \times \times 10^{22}$ m^{-3}, and $(0.8 \pm 0.2) \cdot 10^{22}$ m^{-3} for Eurofer ODS, KP-4 ODS, and 13.5Cr–Fe_3Y ODS, respectively.

SANS studies of specimens of ODS steels were carried out using the YS-SANS instrument ("Yellow Submarine", BNC reactor (Budapest, Hungary)) and CSNS-SANS diffractometer (China Spallation Neutron Source (Dongguan, China)). The measurements at CSNS-SANS were performed under an external magnetic field of 1.1 T, perpendicular to the incident neutron beam. To process the measured SANS curves, a model of spherical particles with a lognormal distribution of these particles by size was used. In the calculation model, two types of particles were assumed, and the contrast values, $\Delta\rho_{ox}$ for oxides and $\Delta\rho_{cl}$ for clusters, were calculated.

The data obtained from the complex analysis of the morphology of ODS steels made it possible to estimate the contributions of various inclusions to the hardening of the material. The dispersion barrier hardening (DBH) model was used to estimate the yield strength. To identify the features of various models of materials in the analysis of SANS curves, the calculated hardness values were compared with the experimental data on micro-indentation of Eurofer ODS, 13.5Cr–Fe_3Y ODS and KP-4 ODS steels. For all three steels, the best result for the calculated hardness was demonstrated by the model with two types of inclusions (oxides or clusters) using SANS data without an external magnetic field. One of the reasons for this may be that the applied field did not make it possible to achieve the saturated magnetization of the steels. Thus, the present study demonstrated that the use of SANS in combination with TEM and APT leads to a better agreement between the hardness calculated on the basis of the morphology obtained in the scattering experiments and the experimental hardness values.

The global crystallographic texture of calcite and aragonite in the shells of the deep-sea hydrothermal species *Bathymodiolus thermophilus*, belonging to the Mytilidae family, was studied using neutron diffraction at the SKAT instrument. A comparison was made with the previously measured global crystallographic texture of calcite and aragonite in the shells of the bivalve mollusks *Mytilus galloprovincialis*, *M. edulis*, and *M. trossulus*, also belonging to the Mytilidae family. It was revealed that the general appearance of pole figures' isolines of both minerals coincides for the studied species. The crystallographic texture sharpness evaluated by means of pole density on the calcite pole figures ({0006} and {10–14}) and aragonite pole figures ({012}/{121} and {040}/{221}) coincides or has close values for deep-sea hydrothermal species *B. thermophilus* and the studied shallow-water species of the genus *Mytilus*. It is concluded that the global crystallographic texture is a stable feature of the Mytilidae family. The extreme habitat conditions of the hydrothermal biotope do not significantly affect the crystallographic texture of *B. thermophilus* [9].

Pottery and ceramic fragments are valuable archaeological objects that reflect the evolution of different cultural or ethnic groups during certain historical periods. A relatively large number of ceramic fragments, as well as high transport mobility when moving pottery along land or sea trade routes, make

it difficult to identify and localize the place of production of ceramic products. Using samples of ancient pottery from excavations in the Dobrudja Region (Romania), systematic studies of ceramic fragments were carried out using neutron tomography, diffraction and Raman spectroscopy [10]. The high penetrating power and the nature of the interaction of neutrons with matter made it possible to determine the phase composition of ceramic fragments, as well as the spatial distribution of some phases within the volume of these archaeological objects. The structural data obtained using neutron methods served as the basis for systematization and group analysis of samples of ancient Byzantine ceramics. This allows one to make assumptions about both the sources of raw materials and the location of pottery workshops. The results of the studies show that not only the phase composition of ceramic fragments can indicate the source of raw materials, but also some structural features observed using neutron tomography can serve as necessary structural markers for assumptions about the place of ceramic production or the chemical processes occurring during the firing of pottery.

OPTICAL METHODS IN CONDENSED MATTER RESEARCH AND PROJECT "NANOBIOPHOTONICS"

The project "Nanobiophotonics" was developed for implementation within the framework of the new theme "Optical Methods in Condensed Matter Research". It is an interdisciplinary research project at the intersection of vibrational (Raman) spectroscopy and microscopy, nanophotonics, photobiology, fluorescence microscopy, and nanobiotechnology in general.

Low-Dimensional Materials: Graphene and Molybdenum Disulfide

Interest in two-dimensional (2D) semiconductors is largely driven by very successful miniaturization of Si-based electronic devices in terms of higher packing density, faster microchip speed, and lower power dissipation. However, this long process of miniaturization, expanding existing material systems, is approaching the physical limit of their functionality. The new awareness of graphene with its unique properties has aroused considerable interest in 2D semiconductors and their potential use in electronics and mechanical systems. Due to the zero bandgap between the valence and conduction bands, graphene absorbs light in a wide range of the electromagnetic spectrum, i.e., in far-infrared (FIR), mid-infrared (MIR), near-infrared (NIR), visible, and ultraviolet (UV) ranges.

Bulk MoS_2 is a semiconductor with an indirect bandgap of ~ 1.2 eV, and is therefore of limited interest to the optoelectronics industry. Individual layers of MoS_2 have radically different properties compared to the bulk. Elimination of interlayer interactions and confinement of electrons in a single plane results in the formation of a direct bandgap with an increased energy of ~ 1.89 eV (visible red). A single monolayer of MoS_2 can absorb 10% of incident light with energy above the bandgap. Compared to a bulk crystal, a 1000-fold increase in photoluminescence intensity is observed, but it remains relatively weak — with a photoluminescence quantum yield of about 0.4%. However, it can be significantly increased (to more than 95%) by removing the defects that are responsible for nonradiative recombination.

Raman Spectrum of Graphene

The main Raman bands, which are related to one-phonon scattering processes are labeled as G (~ 1580 cm^{-1}), defect-assisted D (~ 1350 cm^{-1}), and D′ (~ 1620 cm^{-1}). These bands are accompanied by those related to the respective two-phonon processes, 2D (~ 2680 cm^{-1}), 2D′ (~ 3250 cm^{-1}), and some composite bands, D + D′ (~ 1580 cm^{-1}) and D + D'' (~ 2450 cm^{-1}). Due to the richness and clarity of the Raman spectrum of graphene, it can be used as a fingerprint, and a lot of information can be extracted from any anomaly in the position or intensity of the band.

Identification of Primary Photoacceptors of Photoinduced NETosis

To induce a photobiological effect, any radiation must be absorbed by a functional chromophore/photoacceptor molecule located in some key cell structure capable of influencing its activity and homeostasis. Redox chains are an example of such a key structure. In neutrophil granulocytes, components of the mitochondrial respiratory chain, in particular, cytochrome-c oxidase, and a membrane-bound heterodimeric flavohemoprotein cytochrome-b_{558}, a structural component of NADPH oxidase and containing redox centres, can be considered effective photoacceptors and transducers of the photo signal.

The following concentrations of inhibitors were used in the experiments: apocynin — 400 μM, astaxanthin — 5 μM, Mito-Tempo — 20 μM. The selective effect of these inhibitors depends on the radiation wavelength. In addition to the above, other inhibitors such as azide, trion, DPI, etc. were also tested. The obtained results indicate different signaling

pathways for the formation of NETosis depending on the absorbing chromophore (cytochrome) in the cell. The results were reported at an international conference in Uzbekistan and the AYSS-2024 Summer Scientific School. The work is in progress and will be continued.

METHODOLOGICAL RESULTS

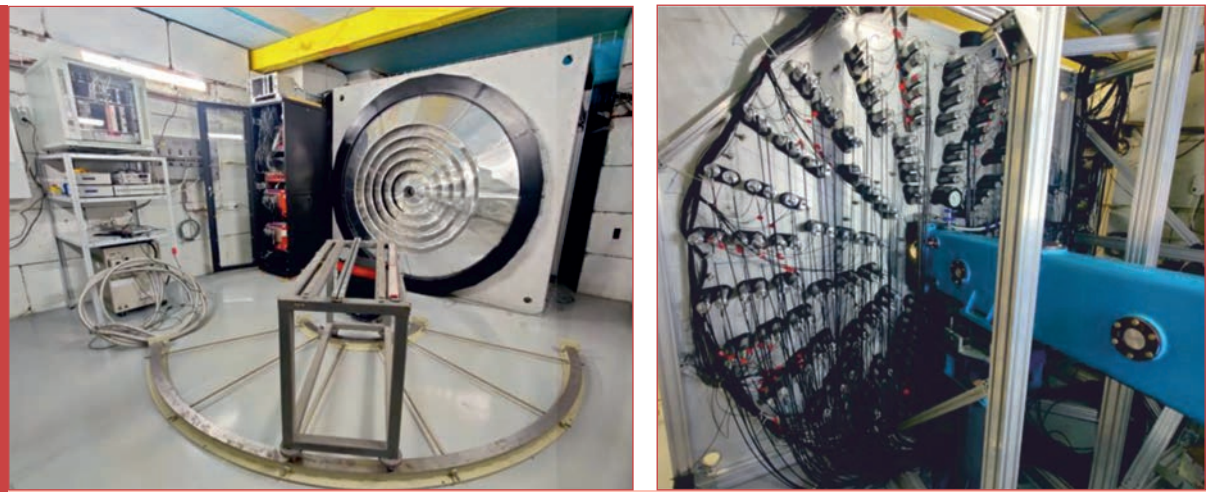
Development of Detector Systems for HRFD and DN-6 Diffractometers

In 2024, work on the installation of a new backscattering detector on the HRFD diffractometer, which began in 2023, was completed. The old equipment (detector and sample environment systems) was dismantled. A new self-leveling floor was poured and the detector frame was assembled. All segments were mounted and 216 photomultipliers, previously tested at the Spectrometers' Complex (SC) Department, were installed. After installation of the detector, a data acquisition system was assembled, including high-voltage sources, preamplifiers and discriminators with MPD-240 modules for transmitting data to the control computer. To connect the detector, more than 600 cables were manufactured and installed, including high-voltage cables for powering the photomultipliers and data transmission cables. At present, the detector is installed in the calculated position and its preliminary adjustment is in progress (selection of thresholds of the discriminators and voltages of the high-voltage units). Further adjustment and precise positioning of the detector will be carried out during the reactor operation.

Work was completed on the creation and installation in working position of a new module of the detector system of the DN-6 diffractometer for collecting neutron diffraction patterns in the range of scattering angles $2\theta = 32–54°$. The module consists of 15 elements arranged in a ring, each element containing six independent ^{3}He counters. The use of this module will significantly improve the luminosity of the diffractometer when measuring diffraction patterns in the specified range of scattering angles.

Project of a New Inelastic Scattering Spectrometer in Inverse Geometry BJN (Bajorek–Janik–Natkaniec)

Work continued on the development and construction of a new inelastic scattering spectrometer in inverse geometry. In cooperation with Atomgraf AG, work was carried out on the selection of manufactured plates made of highly oriented pyrolytic graphite (HOPG). To measure the mosaicity of the plates and select suitable specimens, rocking curves were measured on the STOIK neutron spectrometer (NRC KI, IR-8 reactor). In 2024, data were measured for 522 plates (1044 rocking curves for both sides of each plate), and approximately 100 more plates were planned to be manufactured. The yield of suitable plates varies from 50% to 70% depending on the delivery batch and optimization of their manufacturing technology to obtain the required parameters. Work also continued on the production of a prototype of the focusing analyzer of the spectrometer. It will be equipped with one row of HOPG crystals without a beryllium filter, since its role in eliminating higher-order reflections from HOPG is not significant for the experimental assessment of the parameters of the secondary spectrometer. The creation of the prototype will make it possible to test the technology for manufacturing HOPG plate holders, including boron carbide spacers, and their fastening at a constant value of the Bragg an-



Left: Detector from the sample side, in the foreground — the mounted rotary platform for the 2D PSD detector and the sample environment modules, in the background — the backscattering detector and the data acquisition system. Right: Detector from the neutron guide side, with mounted and connected photomultipliers

gle. At present, the prototype of the focusing analyzer of the new spectrometer has been partially assembled. Also, ^{3}He neutron counters have been purchased, and the manufacturing of the spectrometer detector system is underway.

Continuing Development of Moderators

The development of new promising devices and technologies for cryogenic moderators, including for the new high-flux neutron source developed at FLNP, continued. An experimental prototype of a high-performance dropper for producing solid frozen mesitylene beads similar to Prince Rupert's drops was developed. Based on this prototype, an industrial facility with a capacity of 1.3 l/h with built-in control electronics and a system for counting and rejecting finished beads based on machine vision technology, is being developed.

Also, a very promising development in this area is a facility for the formation of solid frozen beads from methane in a special methane dropper. The first experiments on producing a frozen drop of methane in liquid nitrogen were carried out at the experimental setup.

In the future, the experimental setup will be equipped with a two-stage cryocooler to produce large quantities of solid methane beads in liquid helium, hydrogen or neon.

New Facilities in the JINR Member States

On 12 April, an extended seminar-opening of a new neutron reflectometry instrument at the WWR-K reactor was held at the Institute of Nuclear Physics (Almaty, Kazakhstan), timed to coincide with the Day of Science Workers of Kazakhstan. The neutron reflectometry instrument was built on the fourth horizontal channel of the WWR-K reactor and is designed to study layered and multilayer nanostructured materials. The development and construction of the reflectometer is a striking example of fruitful international cooperation between FLNP JINR and the Institute of Nuclear Physics of the Republic of Kazakhstan. At the SC Department, the main units of the reflectometer were developed and assembled — movable platforms with stepper motors, a detector system with MPD16 electronics; its adjustment was carried out using the adapted Sonix+ software package for experiment control and data acquisition.

NEUTRON NUCLEAR PHYSICS

Measurement of Differential Cross Sections for Neutron Scattering by Carbon within the Framework of the TANGRA Project

In 2024, within the framework of the TANGRA project, experiments continued to study reactions with 14-MeV neutrons with a number of nuclei [11]. Particular attention was paid to inelastic neutron scattering by carbon nuclei.

The structure of ^{12}C is important for describing the processes of stellar nucleosynthesis. In particular, the Hoyle state is of great interest — the second excited level of ^{12}C with an energy of 7.65 MeV, which lies above the threshold for the break-up of

Sharm El Sheikh (Egypt), 14–18 April. Participants of the anniversary, 30th International Seminar on Interaction of Neutrons with Nuclei (ISINN-30)

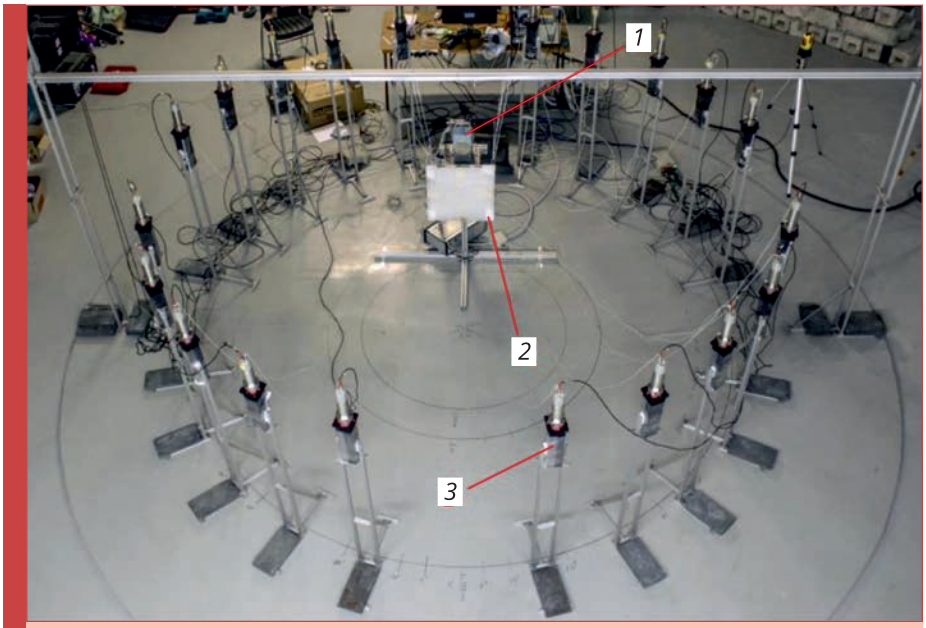


Fig. 3. The TANGRA setup for measuring the angular distribution of neutrons. *1* — ING-27 neutron generator; *2* — carbon sample; *3* — neutron detector

this nucleus into three α particles. Only one excited state of ^{12}C decays with the emission of γ rays, and therefore, to study the properties of the levels of this nucleus with a higher excitation energy, it is necessary to detect scattered neutrons.

An important task is also the correct model description of reactions occurring on the ^{12}C nucleus, and to solve this problem, data on correlations of γ rays and scattered neutrons are required.

To study elastic and inelastic scattering of neutrons by ^{12}C, a specialized setup was designed and constructed, consisting of an ING-27 neutron generator, a sample, and 20 plastic fast neutron detectors placed around it at a distance of 2 m (Fig. 3).

The differential cross sections of elastically scattered neutrons, as well as inelastic scattering with excitation of the first, second, sum of the third and fourth, and seventh levels were measured and calculated in comparison with the obtained data and the results of other studies. In general, all experimental data are in good agreement with each other. The results of TALYS calculations demonstrate satisfactory agreement with experimental data for elastic scattering and inelastic scattering with excitation of the first state after optimization of the optical potential parameters.

Studies of Reactions with the Emission of Charged Particles

Work continues on measuring the cross section for the (n, α) reaction on stable isotopes. In cooperation with Peking University and the China Institute of Atomic Energy (CIAE) in Beijing, the cross sections of the ^{14}N$(n, \alpha_{0,1})^{11}$B reactions were measured at 24 energy points in the neutron energy range of 4.5–11.5 MeV using solid and gas samples [12]. A gridded ionization chamber developed at FLNP was used as a detector. The cross sections of the ^{14}N$(n, \alpha_0)^{11}$B reaction measured using the gas sample and the solid samples are in agreement with each other. *R*-matrix analysis was carried out for the $n + {}^{14}$N system using RAC code in the neutron energy region below 30 MeV. A possible valley structure in the excitation functions of the ^{14}N$(n, \alpha_{0,1})^{11}$B reactions in the neutron energy range of 10–11 MeV was found for the first time.

Development of the Concept of a UCN Source on a Pulsed Reactor

In 2024, work continued on developing the concept of an ultracold neutron (UCN) source at a pulsed reactor. The concept of the source is based on the idea of pulsed accumulation of UCN in a material trap, which will make it possible to develop a source with a high neutron density. To obtain a pulsed UCN flux, it is proposed to slow down very cold neutrons (VCNs) using the magnetic resonance method immediately before entering the trap. A gradient spin-flipper is intended to be used as a moderator device. Since the flipper-moderator is one of the main elements of the planned UCN source, a significant part of the work was devoted to the development of a conceptual design for this flipper.

In close collaboration with the SuperOx company, a conceptual design of a superconducting magnetic system of the unique flipper-moderator, designed for a field of B = 18 T, was developed.

To produce a high-frequency rotating magnetic field in the flipper-moderator, it is proposed to use a birdcage resonator. The resonator model and its parameters were simulated and optimized using the

CST Studio Suite software. On the basis of the work done, the conceptual design of the resonator was developed.

Applied Research

In 2024, work on studying cultural heritage objects and environmental samples continued. Elemental analysis was carried out using neutron activation analysis (NAA) and X-ray fluorescence (XRF). Mineral and molecular composition was studied using Fourier transform infrared spectroscopy and Raman spectroscopy. Additionally, stratigraphy, polarization and optical microscopy, as well as droplet microanalysis were used. Methods of mathematical statistics were applied to process the obtained data. The major part of the objects under study were various components of ancient Russian wall painting (pigments, binders, and plaster bases), medieval building materials, environmental and geological samples.

More than 600 samples from the Cathedral of the Dormition of the Moscow Kremlin, the Church of the Dormition and St. George's Church in Staraya Ladoga were analyzed using *in situ* XRF analysis. About 700 spectra were obtained using a Raman microscope, and about 50 samples were studied using a Bruker's INVENIO FTIR spectrometer.

The work was carried out within the framework of Cooperation Agreements with the Federal State Budgetary Research Institution "State Institute for Art Studies", Interregional Agency for Scientific Restoration of Works of Art, Institute of Archeology of the Russian Academy of Sciences, Federal State Budgetary Institution of Culture "State Historical and Cultural Museum-Reserve 'Moscow Kremlin' ", State Budgetary Cultural Institution of the Leningrad Region "Staraya Ladoga Historical-Architectural and Archaeological Museum-Reserve", INP, Institute of Geology and Geophysics of the National Academy of Sciences of Azerbaijan, as well as within joint projects with Egypt and Vietnam.

A study was conducted to characterize mangrove sediments along the Egyptian Red Sea coast in terms of elemental composition and to assess the extent of heavy metal pollution and its sources. Analysis of sediment samples provides insight into the geochemical properties of mangrove sediments. The study identifies key sources of metal pollution, including industrial effluents, agricultural and urban wastewater. Pollution indices were calculated to track the origin of pollutants. The results indicate significant exposure to heavy metals at several local sites in mangrove sediments, which may pose a risk of bioaccumulation for marine organisms. The results of the study can serve as a tool for managing and reducing anthropogenic impacts on the mangrove environment, as well as for monitoring and predicting possible future changes [13].

Within the framework of the International Programme "Atmospheric Deposition of Heavy Metals in Europe — Estimates Based on the Analysis of Moss Biomonitors", work was completed to assess the level of air pollution in Georgia, Kazakhstan, Serbia, North Macedonia, and Russia (Tver and Ryazan Regions, the Republic of Sakha (Yakutia) and the city of Perm). Specifically, in Perm, a passive moss biomonitoring method was used to assess the level of air pollution. Using a direct mercury analyzer and inductively coupled plasma atomic emission spectroscopy, concentrations of 15 elements were determined in 87 samples of moss *Pleurozium schreberi* [14]. According to the results of factor analysis, the main sources of emissions of potentially toxic elements in the city are transport (automobile and railway), metallurgical and chemical industries. The level of atmospheric air pollution in Perm varies from unpolluted to heavily polluted, with moderate environmental risk.

The method of active moss bag biomonitoring was used in Kamchatka to assess the effect of the Shiveluch volcano on air quality. Moss bags were exposed in settlements located at different distances from the volcano and affected by ashfalls to vary-

June. Environmental studies using NAA

ing degrees. With the exception of Cd, the concentration of elements in exposed moss samples increased compared to unexposed ones, being higher in samples exposed in settlements located close to the volcano. Mosses exposed near the volcano accumulated mainly Al, Fe, Cu, Co, Cr, and V and showed a negative correlation with distance. A positive correlation was found between the distance from the volcano and the Pb concentration in the samples. According to the correlation analysis, the main sources of elements in the moss samples exposed in the studied settlements can be considered to be the deposition of volcanic ash, soil particles, and transport activity [15].

IBR-2 RESEARCH NUCLEAR FACILITY

In 2024, the IBR-2 research nuclear facility was operated in a temporary shutdown mode. In April, JINR obtained a license from Rostekhnadzor for the right to operate the IBR-2 research nuclear facility with a restriction on operation at power until the comments from the expert examination review of the licensing documentation package are addressed. After receiving the license, work was carried out to replace the air heat exchangers of the cooling system of the reactor. In June, an application was submitted to Rostekhnadzor for amendments to the License Terms in connection with rectifying the issues specified in the comments of the expert examination review in order to obtain permission to start up and operate the reactor at power. On 24 December, Addendum No. 1 to the License Terms was received, permitting the operation of the IBR-2 nuclear research facility at power.

In the period from May to December, a specialized organization, together with the IBR-2 personnel, carried out work to replace the air heat exchangers: they were installed in their regular place; testing and commissioning were carried out. The air heat exchangers of loop A and loop B were put into regular operation.

NEW NEUTRON SOURCE

In the context of the development of the project of the new advanced neutron source at JINR, the main objective was a theoretical description of the processes leading to pulse energy fluctuations, as well as a study of the mechanisms for the formation of power feedback using a mathematical model of pulsed reactors.

Despite the fact that to date, for the IBR-2 and IBR-2M pulsed reactors, the limits of permissible pulse energy fluctuations have been determined experimentally, any other configuration of the core of the new reactor of greater power and intensity will require justification of its nuclear safety, including using a model of pulsed reactor dynamics.

3–4 June. A stage of Regional Rosatom–IAEA School on Research Reactors

3–5 December. Participants of the 6th Conference of Young Scientists and Specialists of the Laboratory

Recently, significant progress has been made in the development of a mathematical model for reactor dynamics in the short-pulse and low-background approximation, which is aimed at:

- studying the causes of instability;
- determining the parameters of stable operation;
- developing an optimal core design;
- testing theoretical approaches to the study of dynamics.

This model is a computer program with a modular structure that allows simulating the dynamics of a pulsed reactor using the main parameters (pulsation frequency, average reactor power, decay time of transverse oscillations of fuel rods, their difference in mass, parameters of transverse and thermal reactivity, parameters of pulse transient response in the power feedback model, etc.), boundary conditions, and calculation methods.

Setting the boundary conditions implies choosing the method of fixing a separate fuel rod (or fuel assembly), after which the program uses a particular set of eigenvalues and functions when calculating the equations of motion. Specifying a calculation method implies choosing a method for calculating reactivity ρ in the next power pulse.

The main program cycle is a closed cycle, during which the energy of the next pulse Q_i is calculated, based on the previous values of the pulse energy. The central module here is the kinetics block, in which the neutron kinetics equations are solved based on the known reactivity, the energy of the previous pulses and the modulator speed (parameter ν), and the sources of delayed neutrons and the energy of the next pulse are calculated.

The reactivity value entering the kinetics block is calculated as the sum of reactivity values, each of which corresponds to a specific factor (physical process) that influences the reactor reactivity: automatic regulator, external disturbance, thermal expansion, thermoelasticity (transverse deformations), effect of coolant, and the corresponding program block. The last three factors correspond to feedbacks.

Calculations using this model make it possible to conclude that exceeding the stability limits of a pulsed reactor can be caused by three factors: thermal expansion of the fuel, dynamic bowing of

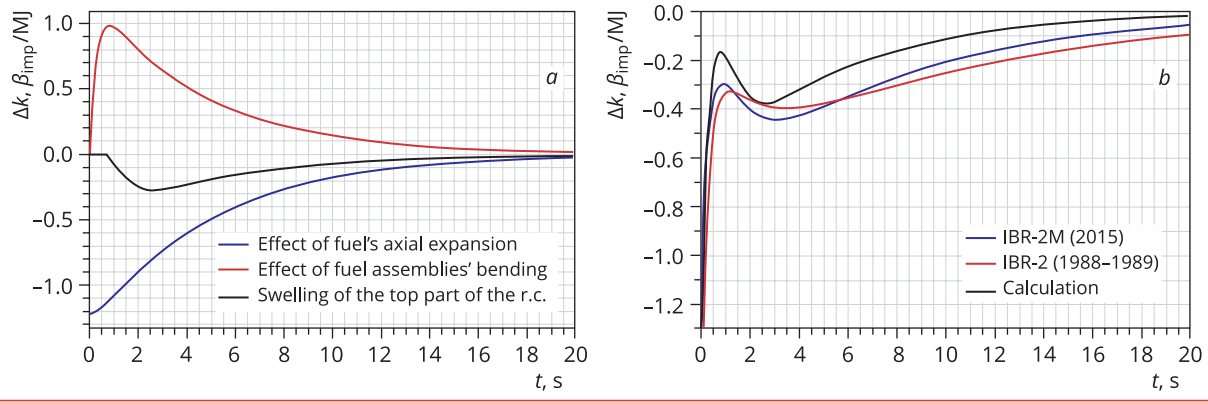


Fig. 4. Functions of the impulse response of power feedback. *a*) Theoretical course of the three components of the impulse response of power feedback of the IBR-2M reactor; *b*) course of the theoretical total impulse response of power feedback and its comparison with experimental data for the IBR-2 and IBR-2M reactors

fuel rods or bowing of the fuel assembly during the pulse, and swelling of the upper part of the reactor core (Fig. 4, *a*). As a result, the following methods for reducing the oscillatory instability of pulsed reactors were proposed: fixing the boundary of the stochastic instability region in order to select the optimal frequency and power of the reactor; selecting the optimal design of the core based on the value of the natural frequencies of transverse oscillations and the repetition rate of the reactor; determining the value of friction of transverse oscillations; using fuel rods of different mass or rigidity.

Taking into account the effects of coolant movement, fuel assembly design and precise temperature distribution in the core will also make it possible to propose other methods for increasing reactor stability in the future. In addition, the availability of the power feedback block in the program, as well as the analysis of calculation results in the form of a pulse characteristic of power feedback, expands the possibilities for studying the dynamics of pulsed reactors. This allows comparative calculations to be carried out using various models, including using numerous results of studies of the dynamics of the IBR-2/IBR-2M reactors (Fig. 4, *b*).

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MESHCHERYAKOV LABORATORY of INFORMATION TECHNOLOGIES

The activity of the Meshcheryakov Laboratory of Information Technologies (MLIT) in 2024 was focused on ensuring the reliable functioning and growth of the JINR network, information and computing infrastructure within the large research infrastructure project 06-6-1118-2014/2030 "Multifunctional Information and Computing Complex" (MICC), as well as on developing mathematical support and software for the research and production activities of the Institute and the JINR Member States (theme 06-6-1119-2014 "Methods, Algorithms and Software for Modeling Physical Systems, Mathematical Processing and Analysis of Experimental Data"). A distinctive feature of ongoing research directions is close cooperation with all the Laboratories of the Institute, institutes of the JINR Member States and other countries.

In 2024, the MLIT staff published over 200 scientific papers, four monographs and more than 100 articles within international collaborations, presented over 150 reports at international and Russian conferences.

MULTIFUNCTIONAL INFORMATION AND COMPUTING COMPLEX OF JINR

The development of scientific research at JINR defines the requirements for the computing infrastructure. The Multifunctional Information and Computing Complex represents a key element of this infrastructure and plays a decisive role in scientific research that entails advanced computing

2 April. Scientific section of the International Conference "Mathematics in the Constellation of Sciences"

power and data storage systems. The MICC is considered as a large research infrastructure project, being a set of hardware and software complexes, systems and subsystems, which embrace the Tier-1 and Tier-2 data processing grid centres, the cloud infrastructure, the HybriLIT platform and the Govorun supercomputer, the data storage, the data transfer system, the network infrastructure, the engineering infrastructure, and the monitoring system. To attain the main objectives of JINR flagship projects, it is needed to ensure the high performance, reliability and availability in 24 × 7 × 365 mode of all MICC components.

In 2024, work to modernize and enhance the performance of the hyperconverged Govorun supercomputer, distributed computing and data storage systems based on grid technologies and cloud computing was underway. The work was based on reliable engineering components and the state-of-the-art network infrastructure with a bandwidth of up to 4 × 100 Gb/s.

The Tier-1 grid site for the CMS experiment at the LHC continued to be a leader among seven similar sites worldwide. Tier-2/CICC provided data processing for the experiments at the LHC, NICA and other large-scale experiments, as well as support for users from the JINR Laboratories and Member States. The cloud environment of JINR and its Member States was mainly used for computing within the JINR neutrino programme.

JINR Network Infrastructure

The development of information technology and the MICC project is directly related to the further development of the JINR network infrastructure, without which the creation of distributed data processing and storage systems within the JINR research programme is inconceivable. The network infrastructure within the MICC project ensures external telecommunication channels, communication between MICC users through the JINR local area network, communication and data exchange through the MICC local area network. The network infrastructure is an intricate complex of multifunctional network equipment and specialized software, which is the foundation for the JINR information and computing infrastructure that has been created and is constantly developing. It consists of the following functional components: the external optical telecommunication data transmission channel; the backbone of the JINR local area network; the local area networks of the Institute's subdivisions; the MICC local area network.

In 2024, the functioning of the JINR telecommunication channels was ensured. First of all, this is the reliable operation of the Moscow backup channel with a bandwidth of 4 × 100 Gb/s. To operate the Tier-1 grid site, one must be a full member of the LHCOPN network to communicate with Tier-0 (CERN) and other Tier-1 sites. This connection is provided by the 100-Gb/s JINR–CERN direct channel and its 100-Gb/s backup channel passing through Moscow and Amsterdam. The JINR Tier-2 connectivity is ensured by the LHCONE external overlay network designed for Tier-2 grid sites. The National Research Computer Network of Russia (NIKS), created as a result of the integration of the federal university computer network RUNNet (Russian UNiversity Network) and the network of organizations of the Russian Academy of Sciences RASNet (Russian Academy of Science Network), provides communication with Russian scientific and educational organizations, as well as integration with individual National Research and Education Networks (NREN) and with the Internet.

The distribution of the incoming (exceeding 25 TB) and outgoing traffics by the subdivisions in 2024 is shown in Table 1.

Table 1

Subdivision	Incoming traffic, TB	Outgoing traffic, TB
MLIT	1240.0	227.1
HRC	502.25	90.35
VBLHEP	465.3	228.01
DLNP	292.28	130.73
FLNP	177.07	69.03
FLNR	176.82	36.16
Dubna State University	163.33	44.18
JINR Directorate	127.81	76.6
Public Access Servers	106.57	97.64
Remote Access Node	88.4	12.57
Medical Unit No. 9	63.81	11
UC	60.39	12.23
BLTP	38.66	24.67
SIMO	35.04	6.38
LRB	30.65	2.85
CPED	26.65	1.96

The overall incoming traffic of JINR, including the general-purpose servers, Tier-1, Tier-2, the Govorun supercomputer and cloud computing, amounted to 42.53 PB in 2024, while the overall outgoing traffic reached 20.62 PB. The traffic with the scientific and educational networks, accounting for 94.05% of the total, is overwhelming.

The local area network (LAN) is based on the JINR backbone network with a bandwidth of 2 × 100 Gb/s and the distributed multinode cluster network between the DLNP and VBLHEP sites (4 × 100 Gb/s) to ensure the reliable transfer of physical data received from the main nodes of the NICA Complex computing equipment for its processing and analysis on the MICC components.

Throughout the year, the e-mail service processed 4 million incoming messages and 850 thousand outgoing messages. The average message processing time was 3 s.

In 2024, over 1700 JINR user requests concerning the operation of the network and services were processed. More than 140 units of various equipment

were configured/checked/installed. About 70 incidents of network security violations and about 130 cases of copyright infringement were identified and processed.

The JINR LAN comprises 13 496 network elements, 22 538 IP addresses in IPv4 format, 1422 IP addresses in IPv6 format, 5718 users (including 5586 JINR staff members), 4773 @jinr.ru email addresses, 1153 users of electronic libraries, 899 users of the remote access service and 147 users of the EDUROAM service. The registration procedures were supplemented with support for new user categories, namely, associated personnel and students.

MICC Engineering Infrastructure

In 2024, work on the replacement and enhancement of the MICC engineering infrastructure [1], designed to ensure the reliable, uninterrupted and fault-tolerant operation of the information and computing systems and the data storage resources, was in progress.

During the year, work to install new servers at the MICC was carried out: 12 × Asus, 2 × Huawei, 30 × SILA CP2-1627, 6 × SILA CP1-1626, and two network switches SILA CK3-630A-32Q. As part of the development of the disk storage of the MICC cloud component (for the JUNO experiment), 8 × ASUS RS720-E10-RS12 were installed.

In 2024, significant work to modernize the power supply system in the MICC modules was performed. The transition to uninterruptible three-phase power supply in the Tier-2 modules was carried out. Cabinets for clean power supply from Galaxy 7000 UPS were installed and put into operation. Due to the fact that standard equipment is not suitable for MICC tasks because of its size and power, special power distribution modules were elaborated, assembled, installed and connected. Special horizontal devices for power distribution in racks were also developed and assembled.

JINR Grid Environment (Tier-1 and Tier-2 Sites)

In 2024, the successful operation of the JINR grid sites continued. Both grid sites provided data processing and analysis within JINR's participation in the LHC projects at CERN, as well as tasks on modeling, processing and storing data from the BM@N, MPD and SPD experiments at the NICA Accelerator Complex.

The infrastructure and services of the Tier-1 (JINR-T1) and Tier-2 (JINR-LCG2) sites ensure computing, data storage, grid support service, data transfer, distributed computing management systems and information services (monitoring, information sites).

One of the major functions of the Tier-1 site is to receive and responsibly store unique experimental data from the CMS experiment transferred from the Tier-0 site to CERN. In addition, the site provides consistent and continuous data processing and reprocessing using new software or new calibration constants, as well as access to various datasets to Tier-1 and Tier-2 sites involved in processing CMS experiment data, etc. For the NICA Complex, simulation tasks for the MPD and SPD experiments are performed on the grid sites. The BM@N experiment has the ability to conduct full experimental data processing using the JINR grid infrastructure.

To organize computing in the grid environment, the Advanced Resource Connector (ARC), middleware for grid computing, and the Slurm workload manager are employed.

Power distribution modules (PDMs) developed at MLIT and installed at the MICC

In 2024, continuous support for lower-level services, which are important for the reliable functioning of both grid sites and the entire MICC as a whole, was ensured. It is noteworthy that without the uninterrupted operation of these services, the operation of the MICC and the JINR IT infrastructure is impossible. These include: DNS and IPDB, services for registering and resolving addresses and names of network elements; a time synchronization service for all JINR machines; Kerberos and LDAP, services for registering IT infrastructure users and for authenticating and authorizing users (in particular, the SSO service); AFS, a distributed file system, a storage of user home directories; CVMFS and GIT, systems for the distributed access and organization of software versions for collaborations and user groups; EOS, a system for storing and accessing large data volumes; a number of services for the JINR grid and international collaborations.

In 2024, a large amount of work on the transition of the Tier-1 and Tier-2 sites to the AlmaLinux 9 operating system (OS) due to the end of the life cycle of the CentOS 7 OS was completed.

One of the uppermost elements of the JINR grid infrastructure, as well as the entire MICC, is the data storage system. The dCache and EOS systems are utilized as the main data storage systems for disk storage, and Enstore and CTA are used for tape storage. In 2024, a number of works related to the technical re-equipment, installation and adjustment of unique hardware and software for the JINR MICC, as well as to the operation and development of the dCache–Enstore data storage system, were completed. Significant work to modify Enstore was done. This comprises converting code from Python 2 to Python 3, organizing the parallel execution of requests for mounting/unmounting tapes in tape recorders, which considerably enhanced the time of these operations, and increasing the throughput of processing a large flow of requests for data transfer.

EOS is viewed as a common distributed storage system for all MICC users with a total capacity of 23.3 PB. The EOS system is used by 32 experiments/user groups to store their data. The distribution by the volume of data stored in the system as of December 2024 (exceeding 50 TB) is shown in Fig. 1.

The EOS–CTA storage system of the TS3500 robot was configured to store data from experiments not

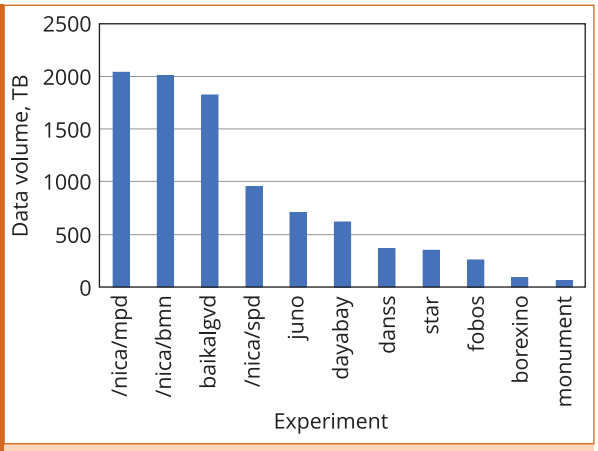

Fig. 1. EOS storage usage by experiments as of December 2024 (data volume exceeding 50 TB)

March. Scientific school for physics teachers. Introductory excursion to the Laboratory

included in the WLCG (Worldwide LHC Computing Grid). The Baikal-GVD experiment was connected to the EOS–CTA system.

Currently, Tier-1 embraces 468 compute nodes (20 096 cores) with a performance of 32.4 kHS23. The launch of tasks for CMS experiment data processing is carried out by 16 nuclear pilots, and all Tier-1 computing resources are available to them. Data storage is provided by the 12.4-PB dCache system and the robotic tape storage with a capacity of 90 PB. The TS4500 robot runs the Enstore and dCache software. To work with tapes, a 2.65-PB disk array is used to cache data.

In 2024, the JINR Tier-1 site took first place in terms of the total normalized CPU time (HS23 hour) for data processed in the ranking of world Tier-1 sites that process data from the CMS experiment at the LHC (Table 2) according to the statistics available at https://accounting.egi.eu.

Table 2

Tier-1	Total CPU time (kHS23 h)	Total actual time (kHS23 h)
RU-JINR-T1	1 888 913.532	2 432 207.483
US-FNAL-CMS	1 665 321.019	3 979 538.749
UK-T1-RAL	1 132 299.978	1 341 419.038
DE-KIT	1 096 517.306	1 349 110.949
FR-CCIN2P3	807 778.212	859 384.319
ES-PIC	671 670.217	701 553.254
IT-INFN-CNAF	618 136.609	692 168.453

The Tier-2 site embraces 485 compute nodes (10 356 cores) with a total performance of 166.8 kHS23. Data storage is provided by the 5.62-PB dCache system. The TS3500 11-PB robotic tape library runs the CTA software and is used for the backup storage of data from local experiments.

The JINR Tier-2 output is the highest in the Russian grid segment (RDIG). In 2024, 2 892 483 tasks were completed on it, which amounted to 90.7% of the total CPU time of the WLCG Russian segment (Russian Data Intensive Grid, RDIG).

The software of the MICC grid sites and storage systems is regularly updated to the latest versions. These include: EOS, CVMFS, Rucio, ALICE VObox, XRootD, UMD, VOMS, the WLCG standard program stack, ARC-CE, the BDII top, the BDII site, OpenAFS, CentOS Scientific Linux, AlmaLinux, GCC: gcc (GCC), C++: g++ (GCC), GNU Fortran (GCC), dCache, Enstore, CTA.

For the simpler and more reliable updating of various MICC system software, test setups for most key components, including the Slurm batch processing system, dCache, EOS, CTA, were installed and configured. This allows for the necessary software updates to be carried out quickly and without significant problems in the main setups.

The key element in the organization of distributed heterogeneous computing infrastructures is connecting middleware (platform), which enables the joint operation of various information and computing systems. Today, the major type of such software at JINR is the DIRAC Interware, a tool for integrating heterogeneous computing and data storage resources into a single platform. Resource integration is based on the use of standard data access protocols (XRootD, GridFTP, etc.) and pilot tasks. Thanks to this, the user is provided with a single environment for launching tasks, managing data, building processes, and controlling their execution.

In 2024, DIRAC (Distributed Infrastructure with Remote Agent Control) continued to be used to solve the tasks of collaborations of all three experiments at the NICA Accelerator Complex. Together with DIRAC platform developers, a method for using the DIRAC pilot pre-installed in CVMFS was proposed and implemented. The implementation of this method entailed making changes to the source code of the DIRAC platform and creating a pilot configuration program at JINR using the version pre-installed in CVMFS. This significantly reduced the load on the local storages of the computing resources. A method for assessing the integrity of files under the management of the DIRAC platform was worked out. The method is based on adding to the files a field of metadata related to the integrity check status. The application of this approach made it possible to check all files of the BM@N and MPD experiments. The peak data transfer rate amounted to 12 GB/s. It is noteworthy that access to the tape robot based on CTA was integrated into the DIRAC infrastructure. This enabled to organize the backup of the data obtained during the 8th session of the BM@N experiment on tapes. In addition, the MPD experiment began backing up some of its most critical datasets.

Heterogeneous Infrastructure

In 2024, the software and information environment of the HybriLIT platform, which is a component of the JINR MICC for massively parallel and resource-intensive computing, was actively developing [2, 3]. The hierarchical data processing and storage system of the Govorun supercomputer was enhanced. It comprises two high-performance servers, each containing two Intel Xeon Platinum 8458P processors with 512 GB of RAM and 32 NVMe Ruler SSDs with a capacity of 30.72 TB, which enabled to expand the volume of the warm data storage subsystem by 2 PB. As a result, the total capacity of the hierarchical storage of the Govorun supercomputer reached 10.6 PB.

Work on developing the polygon with the geographically distributed parallel file system Lustre as a system for simultaneous data processing for computing clusters located at the MLIT and VBLHEP sites was in progress. The polygon embraces the physical nodes of the HybriLIT heterogeneous platform, the VBLHEP NCX cluster, and the Govorun supercomputer with a total disk space of 2.1 PB. Its diagram is demonstrated in Fig. 2.

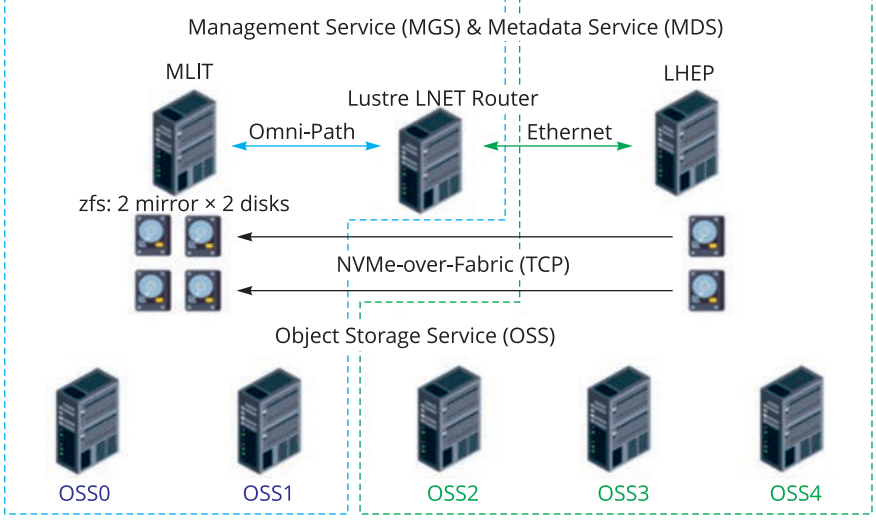

Fig. 2. Geographically distributed parallel file system Lustre located at the MLIT and VBLHEP sites

This prototype consists of two segments that utilize different types of network connections (Omni-Path, Ethernet) and are combined into the common Lustre network using the LNET Router service. The MGS/MDS management services were launched on two servers in High Availability mode. The MGS/MDS data storage section was assembled on a RAID array (mirror), containing a pair of local disks and a pair of network disks connected via the NVMe-over-Fabric protocol (TCP). The OSS data storage servers are distributed geographically, two of them are located in the network segment of the Govorun supercomputer (OSS0 and OSS1 in Fig. 2), the other three are connected to the NCX computing cluster. A number of load tests and a study of the performance of the created polygon, including the usage of the Interleaved Or Random (IOR) Benchmark tool together with MPI technology, were performed [4]. The obtained results showed an increase in the productivity of solving tasks by 30% using the created polygon compared to using local Lustre file systems located at MLIT and VBLHEP with subsequent data exchange between them.

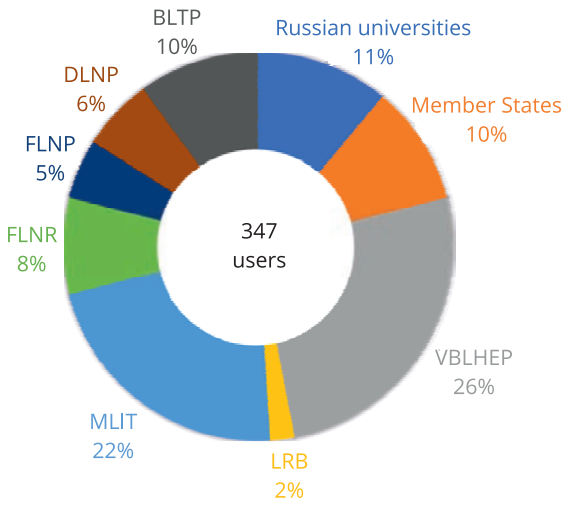

Fig. 3. Distribution of the Govorun supercomputer users by the Laboratories and the Member States

As part of the modernization of the ML/DL/HPC ecosystem for artificial intelligence methods and high-performance computing, an environment for the development of neural network algorithms was prepared to support the activity on the joint project of MLIT and LRB, BioHLIT. It was deployed on a server with eight NVidia A100 graphics accelerators and the AlmaLinux 9.4 operating system. The developed environment embraces JupyterHub 4.0.11 (for the joint development of programs in the Python programming language), the Mercury 2.4.3 framework (for publishing web applications on top of Jupyter Notebook and the Python programming language), the Writer AI 0.7.5 toolkit (for the rapid development of web applications in the Python programming language) and is available at https://mostlit.jinr.ru.

The total number of the Govorun supercomputer users is currently 347. The distribution of users by the Laboratories is shown in Fig. 3.

Throughout 2024, all groups of Govorun supercomputer users computed 6.2 million tasks on the CPU component, which corresponds to 32 million core hours. Figure 4 demonstrates the distribution among the most resource-intensive projects.

The GPU component of the HybriLIT platform is employed to solve high-performance tasks using CUDA technology, for example, for computations in lattice quantum chromodynamics, the development of quantum algorithms and computing with quantum simulators, the elaboration of neural network algorithms and data annotation, the training of neural network models and the deployment of GPU-oriented web services using a neural network ap-

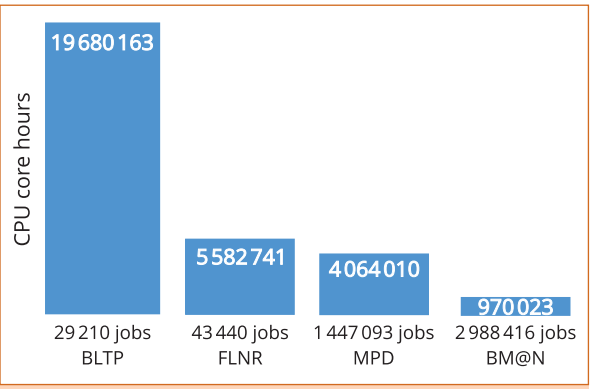

Fig. 4. Statistics on the usage of the Govorun supercomputer resources by the most resource-intensive projects

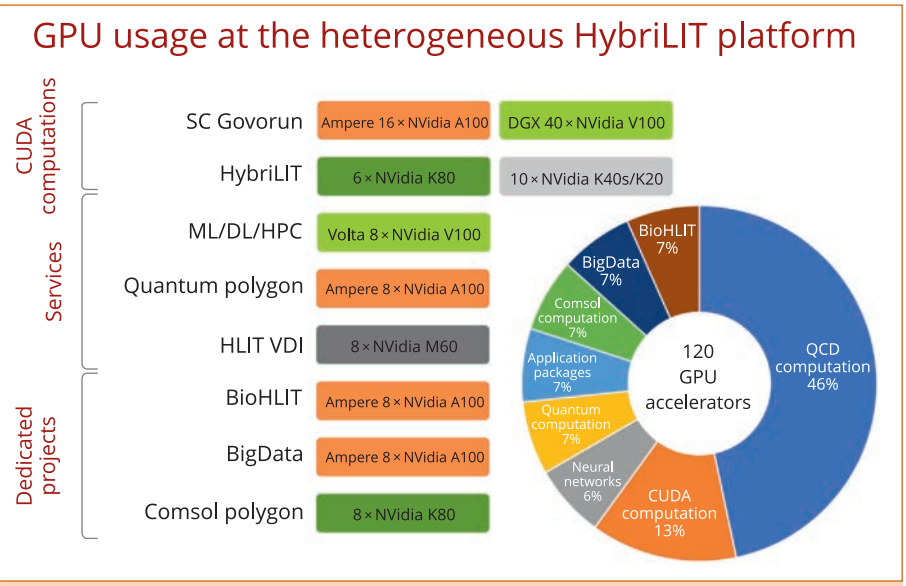

Fig. 5. Structure of employing the HybriLIT platform resources for tasks solved on the platform

proach [3, 5]. The structure of utilizing the graphics accelerators of the HybriLIT platform is displayed in Fig. 5.

In 2024, HybriLIT platform users published 54 papers, including nine in Q1 journals, five in Q2 journals, and eight in Q3 journals.

Cloud Infrastructure

In 2024, the operating systems on cloud infrastructure servers were updated from CentOS 7.9.2009 to AlmaLinux 9.5, and the cloud software was updated from 5.12.0.4 Community Edition (CE) to the stable version OpenNebula 6.10.0 CE. The OS was updated on some cloud virtual machines (VMs) of users and services.

Cloud storages were cleared of obsolete data and virtual machine images, and the transfer of VMs from the decommissioned subnet to a private routed subnet allocated by the network service for the cloud infrastructure was completed.

Within the enlargement of the range of cloud services, a new service for website traffic analysis on top of the Matomo platform, webanalytics.jinr.ru, was deployed. The service was created as a replacement for Google Analytics, which was previously used on the JINR website. It ensures the confidential storage of all collected data in the Institute's local storages and does not require the creation of third-party accounts. The new service can be used to collect statistics on visits to any JINR website. For example, the JINR GitLab service was already connected to it. In addition, it was integrated with the JINR single sign-on system, which provides centralized access to the system web interface.

In 2024, 12 125 668 CPU hours were consumed on the resources of the Neutrino Computing Platform (NCP), which is a segment of the JINR cloud infrastructure. Figure 6 illustrates information on the major consumers.

In reference to the distributed information and computing environment (DICE) based on the re-

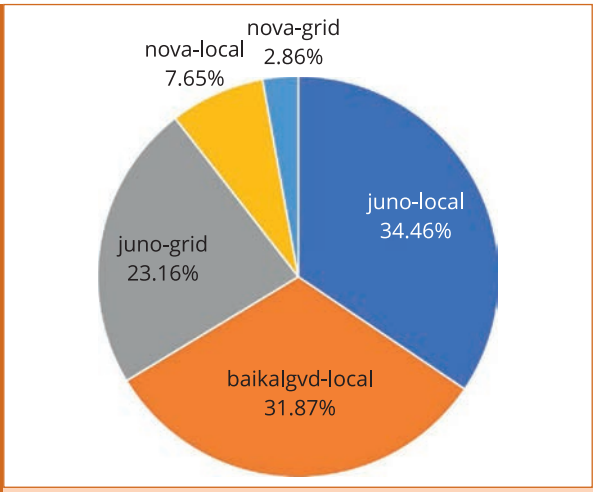

Fig. 6. Number of CPU hours consumed in 2024 on the NCP resources: juno-local, baikalgvd-local, nova-local — by JINR user tasks launched within the JUNO, Baikal-GVD, NOvA experiments by means of the local batch system (i.e., outside the grid); juno-grid, nova-grid — by tasks launched within the grid infrastructure

sources of the JINR Member States' organizations, the main work was related to maintaining the operability and availability of these resources. In addition, MLIT provided technical support to the resources of the Institute of Nuclear Physics (Kazakhstan), Khetagurov North Ossetian State University, and the Institute of Nuclear Physics (Uzbekistan).

Monitoring System

As part of the transition to the AlmaLinux 9 operating system, data acquisition scripts for the monitoring system were rewritten in Python 3. To implement the monitoring of the power supply system, specialized software was developed for collecting data, namely, input voltage, current, consumed power for the IR-23 controller of room 110, as well as for collecting data from the main switchboard of room 110a; an information panel visualizing the main parameters of the power supply systems was created for MICC operators. A similar approach was implemented to monitor the operation of the wet cooling tower (Fig. 7).

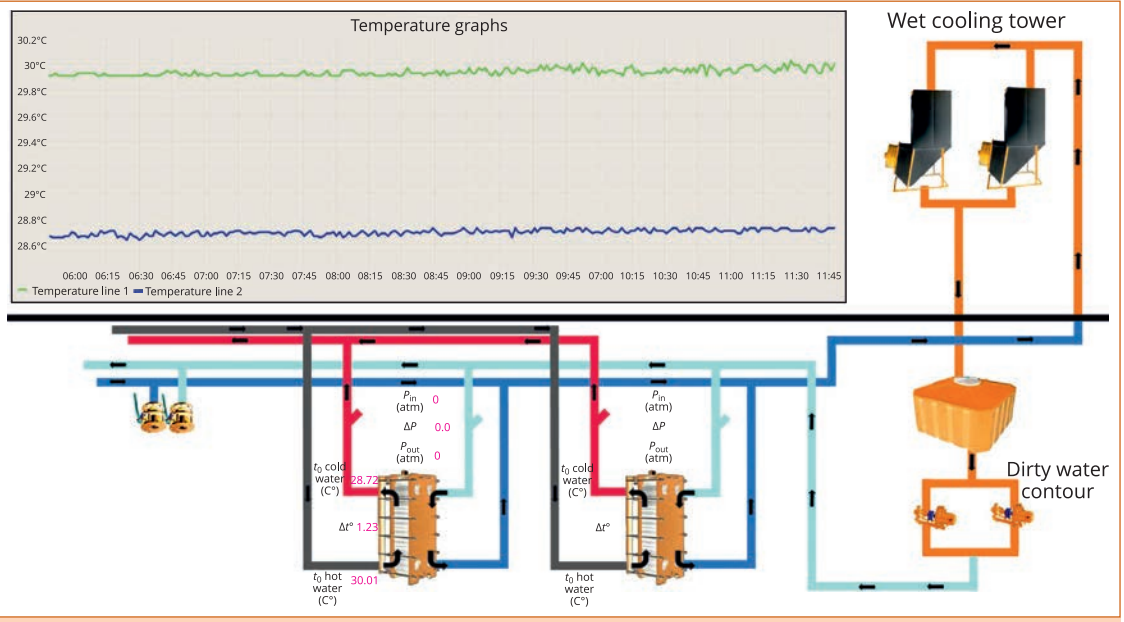

Fig. 7. Information screen of the wet cooling tower monitoring system of the MICC

MULTIPURPOSE HARDWARE AND SOFTWARE PLATFORM FOR BIG DATA ANALYTICS

In 2024, work to create a computing component of the Big Data intelligent analysis platform was carried out on the basis of a research infrastructure that contains computing resources on top of hardware accelerators (GPUs) of several models (NVidia A100, V100, T4). Within the created environment, computing polygons were deployed on Apache Spark and Dask using the RAPIDS software ecosystem; their operability for practical computing was confirmed. In particular, a study on the performance and scalability of the RDataFrame declarative analysis tool of the ROOT package in the distributed Apache Spark environment was conducted.

Within the research infrastructure, software environments and shells for working with open large language models (LLMs) were configured on virtual servers with GPUs. It is planned to employ LLMs for analyzing and abstracting scientific articles, extract-

ing key ideas, forming thematic digests and bulletins, as well as developing recommendation systems, API interfaces and creating various AI assistants of the DES (navigator for JINR publications and scientific results; assistant for regulatory and financial documents, contracts; formulation of procurement requests; support for DES users, etc.).

JINR DIGITAL ECOSYSTEM

In 2024, within the development of the JINR Digital EcoSystem, several institute-wide digital services were put into operation: a document development management service, a calendar for collaborative work, etc. A corporate data bus prototype to integrate digital services and manage information flows was created. Some of the existing digital services were actively developed, and they were integrated with each other and with the basic DES services. The services put into operation are available via the DES interface https://digital.jinr.ru.

The transition to deeply redesigned PIN-2 was completed, it implements new functionality, additional information about the employee (for example, identifiers in citation systems), and data from the previous PIN version was transferred. For user authentication when accessing from foreign networks, the two-factor authorization functionality implemented in the JINR single sign-on system (JINR SSO) was connected.

The JINR Publications Repository was put into pilot operation [6]. The automatic collection of information on publications is performed from three main sources, namely, ELibrary, INSPIRE HEP, and Scopus. Publications are linked to the profiles of users, i.e., JINR staff members. Information on them is available both via the repository web interface and in PIN-2. Currently, the repository contains data on 1890 publications for 2024 and on 9074 publications since 2020.

To organize joint work on documents, the SciDocsCloud software platform, designed to replace the outdated DocDB system, was elaborated.

The functionality for reserving halls and rooms for meetings, conferences and other events was configured in the Indico conference management system.

Work on the current development and support of the following services was in progress: the Dubna EDMS, ISSC, DES Shell, Document Database, Advance Reports, the EDMS "JINR Staff at CERN", ADB2, NICA EVM, Data Exchange Gateway. A hacker attack detection system was developed and implemented in test operation for such services as the Dubna EDMS, PIN, PIN-2, Advance Reports, CERN DB, ISSC, DES Shell.

27–28 May. The Workshop on Mathematical Problems of Quantum Information Technologies (MPQIT-2024)

METHODS, ALGORITHMS AND SOFTWARE FOR MODELING PHYSICAL SYSTEMS, MATHEMATICAL PROCESSING AND ANALYSIS OF EXPERIMENTAL DATA

One of the main activities of MLIT is to provide mathematical, algorithmic and software support for experimental and theoretical research underway at JINR. In 2024, within Theme 1119, a number of works and investigations aimed at the elaboration and enhancement of mathematical methods and software for modeling physical processes and experimental facilities, processing and analyzing data from experiments in elementary particle physics, nuclear physics, neutrino physics, radiobiology, etc. were performed. Highly needed and appreciated contributions were brought to the solution of specific tasks within the BM@N, MPD and SPD projects at the NICA Complex, the CMS and ATLAS projects at the LHC, and the projects of the JINR neutrino programme (Baikal-GVD and JUNO).

A summary of selected results is presented below.

Development and Enhancement of Physical Event Reconstruction Algorithms and Particle Identification Methods

Based on the analysis of data from the BM@N Run 8 (2022–2023) session, software for a detailed description of the geometry of coordinate detectors was developed. Algorithms for modeling realistic responses of track detectors and reconstructing spatial coordinates on microstrip planes were enhanced [7].

To eliminate false measurements in the reconstruction of charged particle tracks in the SPD experiment, a transformer-based neural network architecture was proposed (Fig. 8). An effective use of an attention layer for simulated data was demonstrated with the help of a voxelization procedure [8]. To disentangle overlapping events in one time slice, an approach based on a deep Siamese neural network [9] with a loss function in the form of triplets was developed.

Based on the gradient boosting decision tree (GBDT) algorithm, a method for identifying charged particles produced by the interaction of bismuth nuclei at $\sqrt{s_{NN}}$ = 9.2 GeV was elaborated in the MPD experiment [10]. The use of the XGBoost library showed an advantage over the traditional n-sigma approach, especially for high-momentum particles. The method was adopted by the MPD Collaboration for integration into MPDRoot to solve particle identification tasks (Fig. 9).

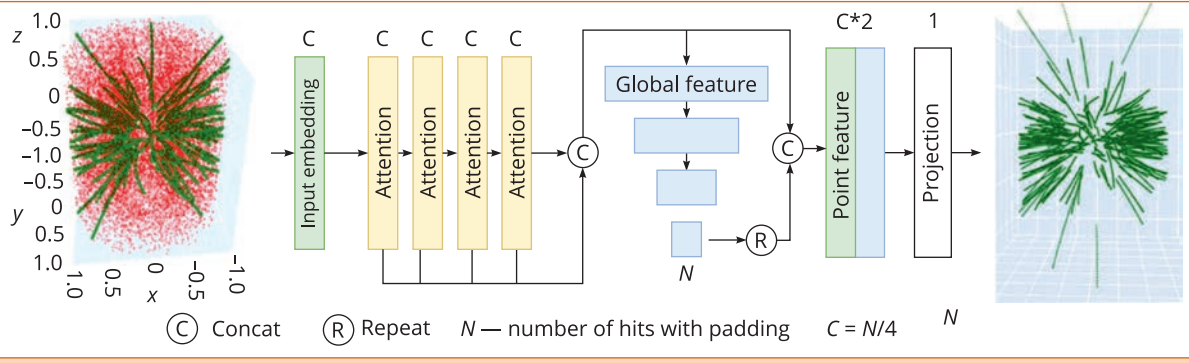

Fig. 8. Transformer-based neural network architecture used for particle track reconstruction

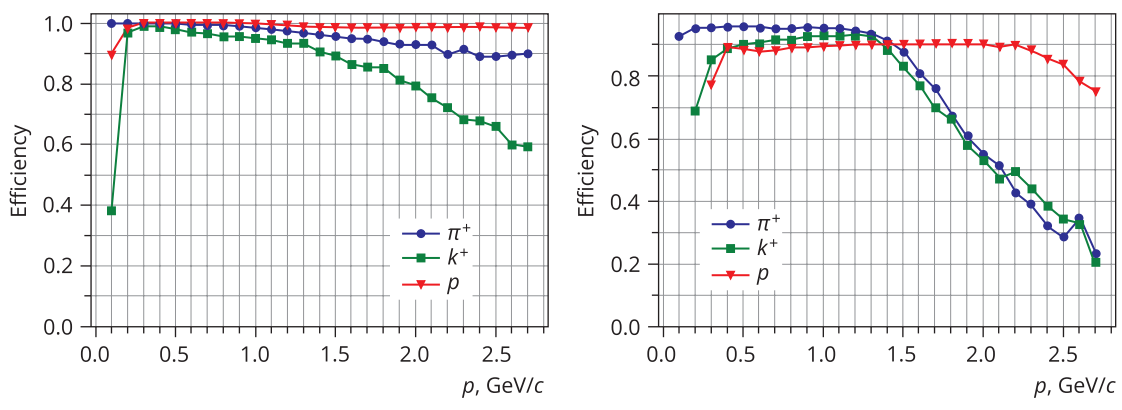

Fig. 9. Effectiveness of charged particle identification in the MPD experiment. Using the gradient boosting method (XGBoost) (left), using the n-sigma method (right)

Development and Enhancement of Methods for Physical Process Modeling and Data Analysis

In 2024, the development of interaction generators for modeling nuclear collision processes at NICA and LHC energies was underway. Analyzing NA61/SHINE data [11] on the production of $\pi^{\pm}$, $K^{\pm}$, protons and antiprotons in ^{40}Ar + ^{45}Sc interactions at P_{lab} = 13–150A GeV/c, it was found that the Geant4 FTF model significantly underestimated the meson yields. A new algorithm for taking into account diffraction dissociation in FTF was proposed, which enabled to increase meson multiplicity and successfully describe the data. The proposed approach gives decent results when applied to BM@N data on the yields of π^{+} mesons in argon–nucleus interactions at an energy of 3.2 GeV.

Using Monte Carlo data, the predictions of two dark matter models, namely, two-doublet Higgs expansion with an additional scalar and axial Higgs singlet, were analyzed. A full simulation of the response of CMS (Geant4) detectors at $\sqrt{s}$ = 13.6 TeV was performed for events with a Z boson and a pair of b quarks associated with a large fraction of the lost transverse energy [12]. The main background processes and optimal kinematic constraints for the maximum signal-to-background ratio were defined.

Within the development of OLVE-HERO experiment data analysis systems, a Monte Carlo assessment of the annual statistics of Earth orbit data for protons (1–45 GeV) was carried out using a spherical detector with a radius of 1.25 m [13]. It was discovered that the addition of 1–5% boron to the scintillator did not affect the registration of energy losses from protons (1, 10, 100, 1000 GeV). For a 5% additive, the energy resolution was estimated in the range of 1–100 TeV.

Within the interlaboratory working group (a joint project of MLIT, LRB, VBLHEP, FLNP, and DRS), studies to assess the radiation situation in the temporary control room of the NICA Accelerator Complex were conducted, namely, a detailed 3D model of the accelerator complex was built in the Geant4 format, hardware and software were configured to perform computing on the Govorun supercomputer, and the estimates of the effective dose rate and neutron spectra were obtained for the model source [14]. To ensure high-energy neutron dosimetry, two methods for neutron spectrum reconstruction based on readings from the Bonner multisphere spectrometer were developed: i) based on spectrum expansion in Legendre polynomials and the numerical solution of the Fredholm integral equation of the first kind using Tikhonov regularization, taking into account the detector "weight"; ii) based on the random forest machine learning algorithm.

Development of Data Processing Systems, Creation and Enhancement of Information and Computing Systems to Support JINR Research Projects

A prototype of a distributed data processing and analysis system integrating the resources of JINR and PNPI NRC "Kurchatov Institute" was deployed for the SPD experiment. In 2024, Monte Carlo simulation tasks were processed on the prepared platform: 200 million events with a total volume of 100 TB were generated [15]. Within the creation of a middleware complex for the real-time event selection system (SPD Online Filter), most of the functional requirements for the software complex were implemented, and work to formalize and implement nonfunctional requirements was performed. Together with colleagues from DLNP, a testbed for developing and debugging the components of the SPD facility data acquisition system was created and put into operation (Fig. 10). The testbed provides an opportunity to develop and conduct long-term tests of hardware

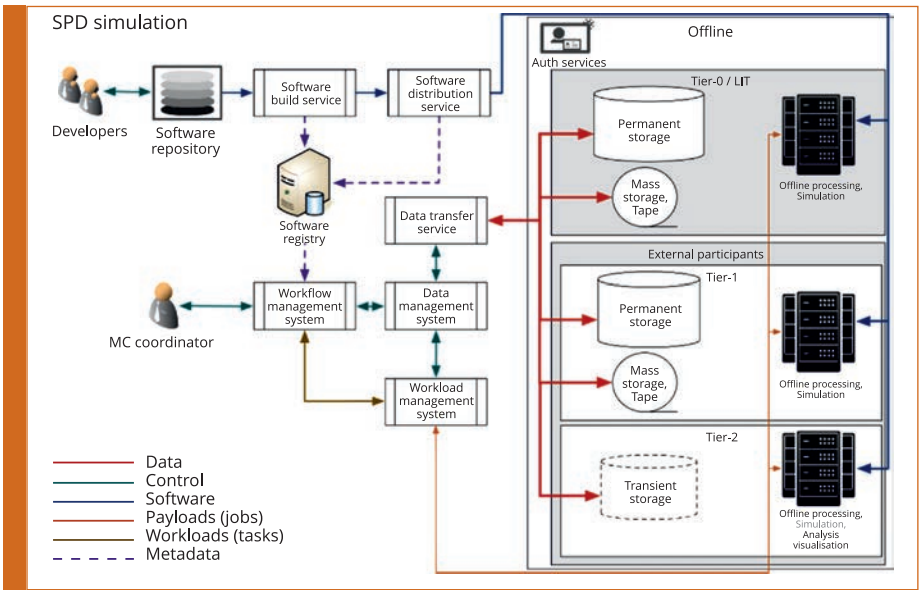

Fig. 10. Scheme of data processing and analysis within the SPD experiment

and software systems and comprises a "cold zone" for placing hardware.

Within the participation of MLIT specialists in the ATLAS experiment at CERN, the resource manager, a component of the TDAQ core, was enhanced. All components of the ATLAS Event Picking service [16] were modernized, and a service user account was created. The experience and knowledge gained in developing databases (DBs) for the ATLAS experiment were applied to the experiments at the NICA Accelerator Complex. Work to create, modernize and support information systems and databases for the BM@N experiment was carried out [17], namely, the configuration (put into production operation) and geometric (ready for test operation) information systems were improved. Within the MPD experiment, work on creating and implementing the Conditional DB and other DBs of the experiment was underway.

Development of Computational Physics Methods

Three monographs were published on the basis of the results of research in applied mathematics and computational physics. The monographs [18] and [19] are devoted to methods and programs for solving systems of equations of various types using the finite difference method, the high-order finite element method (FEM), and iterative schemes on top of the continuous analogue of Newton's method. In [20], the basic concepts, general techniques, and methods for working with matrices, including the calculation of determinants of various orders, are considered.

As part of the cooperation programme with the University of Cape Town (RSA), a study of the spherically symmetric time-periodic standing waves of the φ^4 model in a ball of finite radius was carried out. They are considered as an approximation of weakly radiating oscillons. For the 3D case, coexisting types of standing waves were found, and the dependence of the energy and stability intervals of the waves on the radius and frequency was investigated. Calculations were performed on the HybriLIT platform and the Govorun supercomputer. The frequency range where the variational method provides an accurate description of the (1 + 1)-dimensional oscillon was defined [21].

Molecular dynamics methods were employed to simulate the interaction of beta-amyloid peptide 25–35 with DMPC phospholipid membranes in the presence of a large number of K^+ and Cl^- ions in the solution. The results provide information on possible processes occurring during membrane destruction in the presence of peptides [22].

To describe the collective quadrupole model of the atomic nucleus and compute the rotational-vibrational spectra and probabilities of quadrupole transitions, the GCMFEM program to solve boundary value problems for a system of two-dimensional elliptic differential equations with mixed derivatives was elaborated [23]. For the isotopes ^{190}Os and ^{154}Gd, the results are consistent with experimental data.

Within the microscopic model of the optical potential, an analysis of proton–nucleus scattering data at energies of 200–1000 MeV was carried out. The estimates of the influence of the nuclear medium on the scattering amplitude depending on the energy of the incident proton and the atomic mass of the target nucleus were made [24].

A method for the refined calculation of the spread of energy losses in crystal lattices under irradiation with heavy ions with relativistic energies was proposed, it has an advantage in accuracy compared to existing approaches in the case of irradiation with highly charged ions [25].

The simulation of domains of reversal in the SFS model of the φ_0 junction with weak dissipation depending on the parameters that regulate the action of the external current was conducted. The parallel implementation enabled to reduce the computation time by up to 30 times [26].

A toolkit for modeling the physical properties of a superconducting quantum interference device (SQUID) with two Josephson junctions was developed [27]. Algorithms for calculating the SQUID current-voltage characteristics under the influence of an external magnetic field were implemented using the Numba library.

A scheme for the parallel numerical integration of the three-dimensional nonstationary Schrödinger equation in the representation of a discrete variable, providing a significant reduction in the computation time for such problems with a large number of grid nodes, was proposed and implemented [28].

A combined FEM-based procedure [29] was proposed, it allows reducing computational costs without loss in accuracy when solving 3D magnetostatics problems with complex geometry using a magnetic vector potential.

The FITTER_WEB web application [30], developed and deployed on the cloud infrastructure, was adapted to investigate the structure of phospholipid vesicular systems of various types using small-angle neutron and X-ray scattering data on the basis of the separated form factor model.

A method for extrapolating perturbative expansions in powers of asymptotically small parameters to the region of finite or infinite values of variables was proposed [31]. The extrapolation is performed using self-similar factor approximants. In a number of cases, the method enables to accurately reconstruct the desired functions from their weak-coupling asymptotic expansions.

A quantum-chemical cluster method to quantitatively substantiate effective spin models for various crystal structures of magnetic transition metal oxides was developed [32]. The method is applicable to wide families of new magnetic materials with complex chemical compositions.

Using the example of searching for the ground state in the Ising model with an external magnetic field, the quantum approximation optimization algo-

Yerevan, 21–25 October. 11th International Conference “Mathematical Modeling and Computational Physics” (MMCP 2024) dedicated to the 80th anniversary of the birth of Academician A. Sissakian.
Photo: *https://indico.jinr.ru/event/4467/page/2192-photos*

rithm was tested on the quantum polygon deployed on the HybriLIT platform. Comparative computations were performed on a CPU and a GPU using the CUDA and cuStateVec packages, they confirmed the efficiency of the cuStateVec package [5, 33].

Research in the field of using neural network models to classify images in conditions of a small training sample continued [34]. Software and hardware solutions to organize automated control and accounting in greenhouse complexes are developed. Methods and tools for organizing mobile object tracking complexes are worked out.

A web service based on machine learning (https://mostlit.jinr.ru) was developed, it allows for an automatic analysis of DNA double-strand breaks (DSBs) in mammalian and human cell nuclei relying on the counting of radiation-induced foci (RIF), which represent repair protein clusters at the DSB site. By processing a series of fluorescent images of cell nuclei, the service provides analytical information on key RIF parameters, such as the average number of RIF per cell nucleus, RIF area, and intensity.

EDUCATIONAL ACTIVITY

Within the educational activity, the JINR Spring and Autumn Schools of Information Technologies (IT Schools) were held in 2024. Ninety students from different Russian universities participated in the IT Schools. Since 2022, 18 people have become JINR employees according to the results of a series of IT Schools. More than 40 theses of postgraduates, Master’s and Bachelor’s students were prepared and defended in 2024 under the supervision and scientific advice of the MLIT staff. Over 20 non-graduate students work on JINR projects and come for practice. In 2024, the education and testing polygon of the HybriLIT platform was actively used for conducting semester-long training courses and within schools and workshops. Semester-long training courses on the IT disciplines “Architecture and Technologies of High-Performance Systems”, “Parallel Distributed Computing”, “Languages and Technologies of Data Analysis”, “High-Performance Computing Technologies”, “Mathematical Computing Software”, held at Dubna State University and Tver State University, were attended by 457 students. In addition, four Bachelor’s and two Master’s theses were prepared on the basis of the HybriLIT platform. The educational Master’s programme “Data Processing Methods and Technologies in Heterogeneous Computing Environments” was developed and licensed, the curriculum and work programmes of disciplines in direction 01.04.02 “Applied Mathematics and Computer Science” for the MSU Branch in Dubna were elaborated. To develop cooperation, seminars were held for students of such educational institutions as Lomonosov Moscow State University, Plekhanov Russian University of Economics (PRUE), and the PRUE Economic Lyceum.

15–16 April. JINR Spring School of Information Technologies

7–11 October. JINR Autumn School of Information Technologies

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LABORATORY of RADIATION BIOLOGY

In 2024, the Laboratory of Radiation Biology (LRB) continued research within the framework of Theme 05-7-1077-2009 "Research on the Biological Effects of Ionizing Radiation with Different Physical Characteristics". LRB staff conducted experiments at JINR's ionizing radiation sources CellRad, SARRP, and IREN, as well as at partner organizations: A. Tsyb Medical Radiological Research Center (Obninsk, Russia), Physics and Technology Center of the Lebedev Physical Institute of the Russian Academy of Sciences (Protvino, Russia), and CENTIS (Havana, Cuba). In 2024, specialists from scientific institutions of Belarus, Egypt, and Serbia visited LRB to participate in research.

Dubna, 11 October. Meeting of LRB Director A. Bugay with the assistants of the Plenipotentiaries of the Governments of Cuba and Mongolia

MOLECULAR RADIOBIOLOGY

The modifying effect of the DNA repair synthesis inhibitor, cytosine arabinoside (AraC), in combination with benzamide, an inhibitor of the PARP1 enzyme involved in the repair of DNA single-strand breaks, on the formation of radiation-induced DNA double-strand breaks (DSBs) has been studied using DNA comet assay in a culture of B16 mouse melanoma cells [1]. After X-ray exposure at 0–5 Gy (a Precision CellRad facility: 5 mA, 130 kV, 1.5 Gy/min), a sharp increase in the number of DNA DSBs was observed for the combined action of AraC and benzamide compared with irradiation without modifiers or in the presence of one modifier. It was established that DNA DSB repair in the presence of

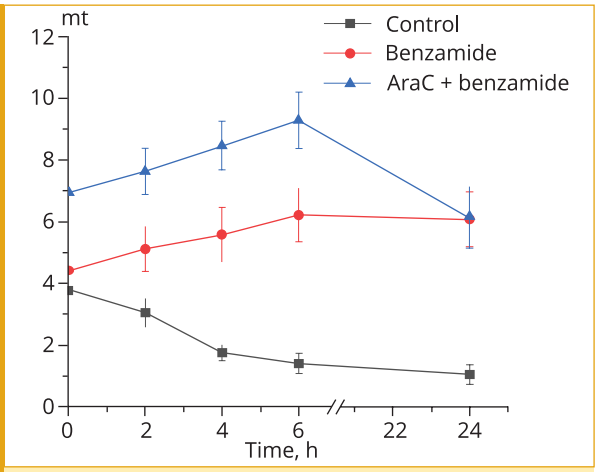


Fig. 1. DNA DSB repair kinetics in B16 mouse melanoma cells exposed to 5 Gy of X-rays under normal conditions (control) and in the presence of AraC and benzamide

inhibitors is characterized by a curve with a maximum at 6 h of postirradiation incubation, in contrast to the smoothly descending exponential curve of repair kinetics without modifiers (Fig. 1).

The effectiveness has been assessed of the combined action of AraC and proton radiation at a dose of 10 Gy on DNA DSB formation in Ehrlich ascites carcinoma (EAC) cells *ex vivo* and *in vivo*. DNA DSB formation was measured by DNA comet assay. The number of DNA DSBs formed in the presence of the modifier was found to increase for both *ex vivo* and *in vivo* exposure compared with the irradiated control. At the same time, the number of DNA DSBs in EAC cells after irradiation *in vivo* was significantly higher than after irradiation *ex vivo*.

RADIATION GENETICS AND CYTOGENETICS

The biological effectiveness of LRB's CellRad and SARRP X-ray facilities has been evaluated using the mFISH (multicolor fluorescent *in situ* hybridization) method for whole-genome chromosome staining [2]. It has been shown (Fig. 2) that the average number of aberrations per cell induced in blood lymphocytes of one donor by 130-kV radiation at the CellRad with additional 0.1-mm Cu filtration and 220-kV radiation at the SARRP does not differ from that obtained previously at a 250-kV X-ray facility (Seifert, GSI, Germany). The spectrum of aberrations induced by all three types of X-radiation was similar: about 20% were simple breaks, 60% were simple exchanges, and 20% were complex aberrations. Thus, radiation in these operation modes can be used as a standard in radiobiological studies.

The results of a cytogenetic study of monkey and human lymphocytes after *in vitro* blood irradiation with 170-MeV and 1-GeV protons have been obtained and summarized [3]. The main type of chromosomal aberrations detected by the standard metaphase method in monkey blood lymphocytes after proton irradiation was dicentrics. A power-law linear-quadratic dependence on the dose was ob-

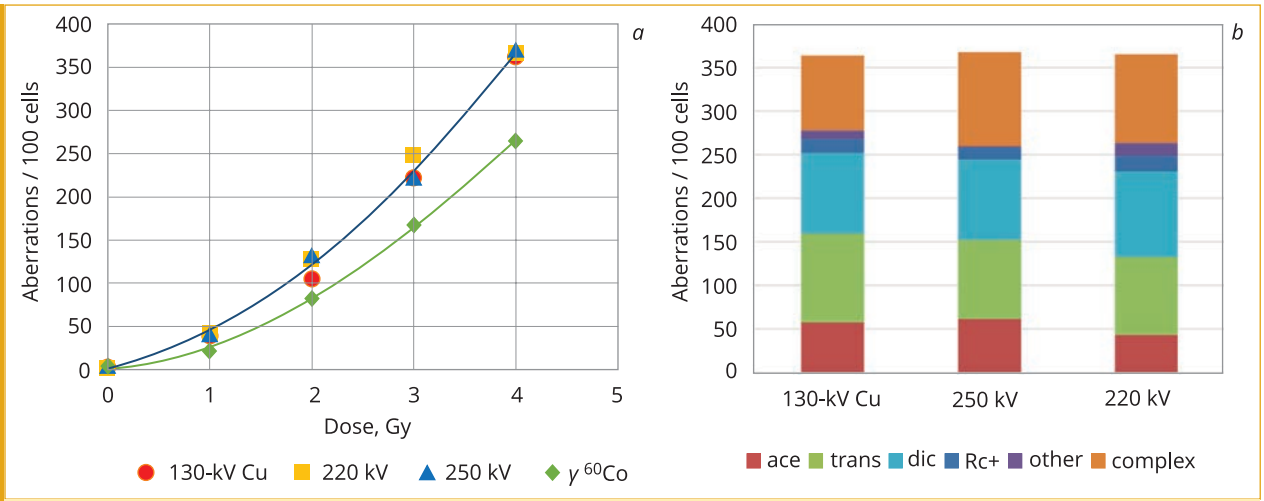


Fig. 2. *a*) The average number of aberrations per 100 cells induced in blood lymphocytes of a healthy donor by 130-kV radiation, CellRad, with additional 0.1-mm Cu filtration (130-kV Cu); 220 kV, SARRP (220 kV); 250 kV, Seifert (GSI, Germany: *Lee et al.* // Mutat. Res. 2010. V. 701. P. 52) (250 kV); and ^{60}Co γ rays, Rocus-M (JINR) (γ ^{60}Co). *b*) The spectrum of aberrations induced by the same radiation at a dose of 4 Gy: acentrics (ace), translocations (trans), dicentrics (dic), centric rings (Rc+), other simple exchanges (other), and complex aberrations (complex)

Dubna, 24 November. Students of the MSU Faculty of Medicine get acquainted with the methodology of conducting behavioural experiments on small laboratory animals

served for the total number of chromosomal aberrations due to the contribution by double-hit aberrations. The data from the analysis of chromosomal abnormalities show a wide spectrum of chromosomal aberrations, an increase in their yield with an increase in the exposure dose, and the absence of significant quantitative differences between monkey and human cells, which confirms the similar radiosensitivity of the objects under study.

The long-term effects on neurological manifestations and biochemical, cytogenetic and hematological indicators of *Macaca mulatta* monkey blood were studied after local irradiation of the head with 2.58-GeV/nucleon ^{78}Kr ions [4]. In irradiated animals, showing deviations from standard behavior, observed were lower ratios between lymphocytes, platelets, neutrophils, and monocytes; changes in liver function tests; a higher level of chromosomal aberrations.

The analysis of structural rearrangements of plasmid DNA in mutants formed as a result of irradiation of yeast cells with 42-keV/μm ^{11}B ions has been continued. The size and localization of deletions were determined by genetic and electrophoretic analysis. PCR amplification of the regions of interest and sequencing of the amplified fragments were performed using selected primers. Mutants induced by doses of 50 and 75 Gy and losing three genes were analyzed. It has been shown that deletions of 2211–6190 nucleotide pairs can be accompanied by point mutations in the form of base pair substitutions, nucleotide insertion, and loss of one or more nucleotides.

MEDICAL RADIOBIOLOGY

The effects have been studied of single and combined action of proton and neutron radiation on the population of cancer stem cells (CSCs) [5]. CSCs are the most resistant fraction of tumor cells to damaging factors; therefore, they play the key role in metastasis and tumor recurrence after treatment. The number of $CD44^{+}CD24^{-/low}$ CSCs decreased after combined irradiation at a total equieffective dose of 4.0 Gy compared with the control — in contrast to the action of gamma radiation, which leads to an increase in the number of CSCs. A synergistic decrease in the CSC pool was observed after combined neutron and proton exposure if the contribution of the two types of radiation to the total dose was the same, and the time between irradiation sessions did not exceed 4 h.

The combined action of AraC and fractionated proton irradiation on the B16 murine melanoma

and its molecular and cellular mechanisms have been studied *in vivo* [6]. Five weekly proton irradiations at a total focal dose of 50 Gy in the presence of AraC resulted in a more pronounced inhibition of B16 melanoma growth than irradiation in the same mode without AraC. It has been shown that the administration of AraC enhances the antitumor effect of proton irradiation through several mechanisms, including a decrease in the number of CSCs and inhibition of cell proliferation and angiogenesis in the tumor against the background of a change in the immune response in the primary lesion and its infiltration with lymphocytes.

Long-term side effects of the combined proton and AraC exposure on the physiological parameters of the immunocompetent organs of rats were studied 90 days after irradiation [7]. The toxicity of AraC during repeated administration was assessed. A marked change in hematological parameters was observed two months after 5-fold administration of AraC against the background of the absence of histopathological changes in the liver, spleen, and kidneys during routine histological examination.

The modifying effect of AraC has been studied for proton irradiation of Ehrlich ascites carcinoma *in vivo* and *ex vivo*. After proton irradiation, the tumor growth rate decreased in the presence of AraC both *in vivo* and *ex vivo*. The strongest antitumor effects of AraC in combination with proton exposure were observed after irradiation of ascites cells *ex vivo*. This may indicate a difference in the effect of AraC on cells irradiated *in vivo* and *ex vivo* — both at the stage of primary oncogenesis and during the development of the formed neoplasm.

RADIATION PHYSIOLOGY AND NEURORADIOBIOLOGY

The functional activity of the rat brain was analyzed after X-ray exposure (the SARRP facility) at a dose of 10 Gy. A statistically significant decrease in the absolute spectral power of the electroencephalography (EEG) was noted for the θ wave during the first 4 days after X-irradiation of the rat brain; for the α wave — during the first 6 days (Fig. 3). Statistically significant weakening of the β wave was observed only on the 3rd day after irradiation.

The dynamics of the neuroinflammatory response in the brain of ICR and C57BL/6 mice was assessed in the short-term (24 and 48 h) and long-term (2, 6 and 12 months) periods after irradiation with Bragg peak protons at doses of 2, 5 and 10 Gy. For

Dubna, 19 February. Visit to LRB by representatives of the A. I. Burnazyan FSBI of FMBA of Russia (Moscow) and specialists of the FSBI "Federal Scientific and Clinical Center of Medical Radiology and Oncology" of FMBA of Russia (Dimitrovgrad)

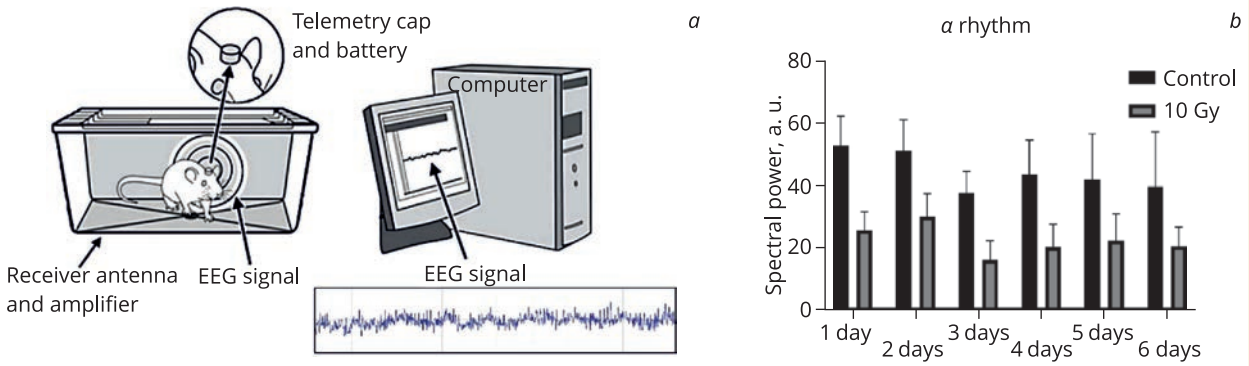


Fig. 3. *a*) A scheme of measuring the EEG signal in irradiated rats. *b*) The spectral power of *α* waves at different times after X-irradiation at a dose of 10 Gy at the SARRP facility

this purpose, the levels of IL-1*β*, arginase I, and inducible NO synthase were measured in mouse brain homogenates. The obtained concentrations were normalized to total protein amount in the samples. When studying the content of IL-1*β*, a decrease in cytokine secretion was observed 48 h after proton irradiation at a dose of 10 Gy, and a dose-dependent decrease in its concentration in mouse brain homogenates was noted after 6 and 12 months. A statistically significant decrease was observed in the arginase I content in the mouse brain in the short term after proton irradiation at a dose of 10 Gy. A decrease in the arginase I level in brain homogenates was also noted 2 and 12 months after exposure. In studying the concentration of inducible NO synthase, no statistically significant differences were found between the groups of animals. Analysis of the obtained data indicates that the studied biomolecules are important components in the development of a neuroinflammatory response. Based on this, the study of their content becomes a promising direction for predicting and preventing the effects of radiation on the central nervous system.

MATHEMATICAL MODELING OF RADIATION-INDUCED EFFECTS

Mathematical modeling has been performed of the induction and repair of chromatin breaks in normal and tumor cells after X-ray and *γ*-radiation exposure. The average number of DNA double-strand breaks (DSBs) in the region of one chromatin break has been determined. There is good agreement between the theoretical curves and the experimental data obtained by the premature chromatin condensation technique, which makes it possible to predict the cellular response to irradiation [8].

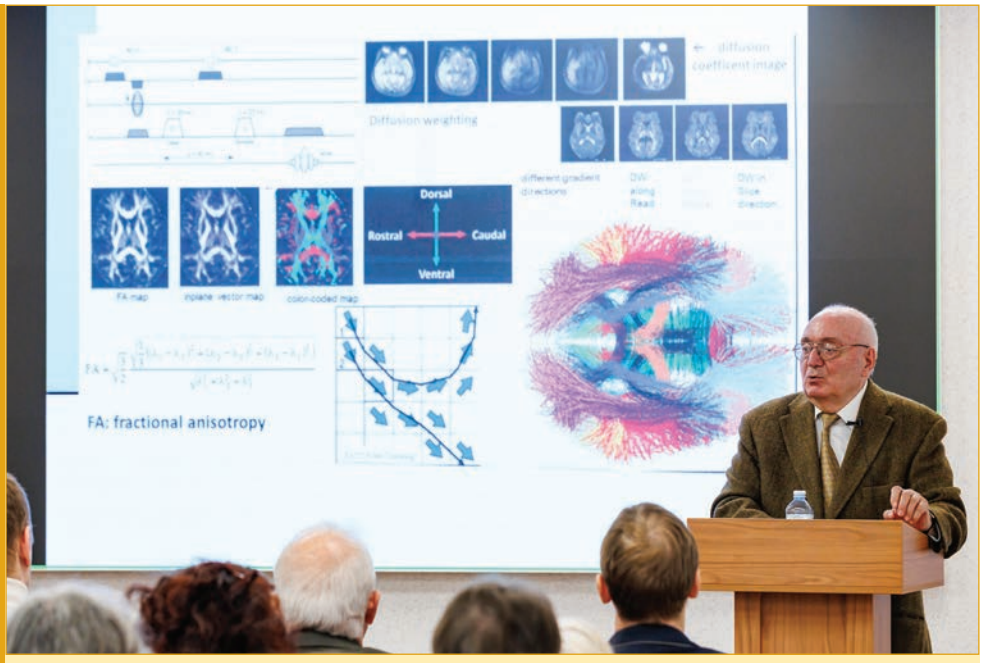
The effect of epithermal neutron beams on brain tumor cells has been simulated for different concentrations of boron nanoparticles in the cell. Using the Geant4-DNA software toolkit, the DNA DSB yield was calculated for different nuclear cell geometries and boron concentrations [9].

Using molecular dynamics modeling methods, it has been shown that oxidation of amino acid residues of glutamate receptor proteins due to their interaction with radiolysis products can lead to disruption of the neural networks of the brain. As a result of the study, electrophysiological characteristics of the hippocampal neural network model have been obtained depending on the modifications of the receptor ion channel. The character has been determined of the dependence of the peak values of the power spectrum of the main EEG rhythms on the conductivity of the AMPA and NMDA receptors with modified tryptophan [10].

The mechanisms have been considered of the formation of direct and indirect molecular damage in the genetic apparatus and synapses of nerve cells due to physical processes leading to breaks in connections and chemical reactions with water radiolysis products. Physical and chemical processes, as well as geometric shapes of the biological target, which play an important role in radiation-induced effects at the level of individual neurons and their population, have been studied [11].

A biophysical model has been proposed of the formation of the main types of radiation-induced base damage as well as DNA single- and double-strand breaks in mammalian and human cells after exposure to intense laser pulses of the visible and near-IR ranges. It has been shown that the main contribution to DNA damage formation is made by multiphoton photoionization, avalanche impact ionization, and interaction with water radiolysis products [12].

A mathematical model of the survival of a heterogeneous population of neural stem cells (NSCs) has been developed. Using the model, NSC survival has been calculated depending on age and the effect of exposure to X-rays, *γ*-rays, and ^{56}Fe particles in the



Dubna, 3 April. LRB general laboratory seminar "Molecular Basis of Intelligence. Kinetics of Chemical Reactions in the Human Brain. Neuroengineering". The speaker is RAS Corresponding Member S. Varfolomeev

dose range of 0–5 Gy. The model reproduces experimental data and predicts the emergence of two NSC survival modes in response to irradiation, differing in the rate of activation of the division process of dormant neural stem cells. Survival curves have been calculated for dividing progenitor cells, immature neurons, and mature neurons after irradiation with accelerated ^{12}C, ^{28}Si and ^{56}Fe ions [13].

RADIATION RESEARCH

The development of new approaches to modeling mixed radiation fields at heavy charged particle accelerators for radiobiological experiments is ongoing. A mathematical model of a galactic cosmic radiation simulator has been developed — a special facility potentially capable of reproducing a mixed ionizing radiation field at a beam of relativistic heavy nuclei to simulate space radiation conditions [14]. As part of this work, a program was created to calculate the spectra of primary particles of galactic cosmic radiation for different solar activities determined by the Wolf number. The results of computer modeling show that the proposed simulator can be constructed at SIMBO — a NICA Complex-based station for applied research on medical and biological objects — to conduct unique radiobiological experiments in radiation fields simulating radiation fields in space. This study formed the basis of a dissertation, which was successfully defended in 2024 [15].

Modeling the radiation conditions on the premises of the NICA Accelerator Complex continues. Together with Veksler and Baldin Laboratory of High Energy Physics staff, modeling the radiation conditions at the SIMBO and ISCRA stations and channels for applied research at the NICA Complex has been successfully completed. The limiting intensities at which the established zoning of the staff rooms is observed have been calculated. The obtained estimates show that the adopted design solutions will ensure compliance with radiation safety standards during operation of the stations with the limiting beam intensities determined by modeling.

In cooperation with the Frank Laboratory of Neutron Physics (FLNP), a method for reconstructing neutron spectra using the Bonner multisphere spectrometer has been developed [16]. Neutron energy spectra behind the biological shielding of FLNP's IREN resonance neutron source have been obtained at electron energies of 60 and 100 MeV. The effective neutron dose rates at the measurement points have been determined, which is important both for assessing the radiation conditions at IREN and for comparison with the readings of neutron dosimeters of the automated radiation monitoring system. A method for reconstructing neutron spectra using the RECONST program is being developed. A new method for reconstructing neutron energy spectra using the expansion of the neutron spectrum by shifted Legendre polynomials with the use of Tikhonov regularization based on the Bonner spectrometer readings is being worked out [17]. The construction of a prototype of the DVN-1 high-energy neutron dosimeter is underway.

ASTROBIOLOGY

Comparative micropaleontological study of the meteorites Allende, Dhofar 019, Jbilet Winselwan, Kilabo, Murchison, NWA 10178, Orgueil, and Tissint, as well as samples of Lower Proterozoic gneisses of the Eastern Sayan Mountains (2.5–1.65 billion years) is ongoing using a scanning electron microscope with an X-ray microanalyzer. New finds of prokaryotic and eukaryotic microorganism remains were made in meteorite samples.

A collective monograph titled “Astrobiology” has been published [18], which is the first attempt to summarize the accumulated astrobiological knowledge. The book is authored by specialists from different countries and fields of science. The editor-in-chief is Head of the LRB Astrobiology Sector, a prominent Soviet and Russian specialist in biology, geology, paleontology, and stratigraphy, Academician of the Russian Academy of Sciences (RAS) A. Yu. Rozanov. The book presents the history of the development of views on the origin of life and the stages of the development of astrobiology as a science; describes the facts and models on which these concepts are based; outlines a range of unresolved issues and promising areas of research. The publication includes results provided by a wide group of authors from JINR, RAS Institute of Physical, Chemical and Biological Problems of Soil Science, RAS Space Research Institute, RAS Institute of Microbiology, RAS Paleontological Institute, RAS Institute of Physics of the Earth, Institute of Catalysis (RAS Siberian Branch), and the U.S. Space and Rocket Center.

Academician A. Yu. Rozanov and a number of co-authors of the monograph “Astrobiology”

CONFERENCES AND EDUCATION

In 2024, LRB staff participated in 15 international and Russian scientific conferences.

On 16–18 October, an International Conference titled “Current Problems in Radiation Biology. Modification of Radiation-Induced Effects” was held in Dubna. It was participated by more than 100 radiobiologists from Armenia, Azerbaijan, Belarus, Cuba, Mongolia, Russia, and Vietnam. By the beginning of the Conference, its proceedings were published (Dubna: JINR, 2024. 129 p.). Five plenary and 52 oral reports were made; 10 poster reports presented by young scientists were considered.

On 25–28 February, the International School on Nuclear Methods and Applied Research in Environmental, Material and Life Sciences (NUMAR-2024) was held in Varadero (Cuba), organized by the Joint Institute for Nuclear Research and the Cuban Agency for Nuclear Energy and Advanced Technologies.

Over 30 students and young scientists from Costa Rica, Cuba, the Dominican Republic, and Mexico took part in the School.

The educational process continued at the Department of Biophysics of Dubna State University. The Department's current total enrolment is 27 students and four postgraduates. In 2024, three students successfully completed their programmes and received a Master's degree in physics.

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UNIVERSITY CENTRE

JINR-BASED EDUCATIONAL PROGRAMMES

In 2024, academic programmes were organized for students at the JINR-based departments of MSU, MEPhI, MIPT, Dubna State University, Saint Petersburg State University, and Kazan Federal University. A total of 520 students from universities of the JINR Member States completed their internships and practical trainings at JINR.

The University Centre organized the process of Doctoral Candidacy Examinations in the chosen specialty for seven JINR employees assigned to the MIPT Basic Department of Fundamental and Applied Problems of Microworld Physics. Since 2018, 51 people have passed the candidacy examinations at the Department.

Resumption of UC Council

On 29 November, JINR Scientific and Technical Council (STC) discussed the problem of attracting highly qualified scientific personnel to the Institute. The STC supported the resumption of the work of the UC Council in order to form a strategy for the development of educational programmes at JINR and improve personnel training. The members of the Council were approved by the order given by JINR Director at the end of 2024.

Dubna, 3–21 June. Students from RSA universities are the participants of the International Student Practice in JINR Fields of Research

INTEREST Programme

Eighty-five students and postgraduates from Belarus, Brazil, Cuba, Egypt, Germany, India, Mexico, Romania, Russia, Sweden, Turkey, Uzbekistan, and Vietnam, took part in two waves of INTEREST (INTErnational REmote Student Training at JINR) online programme in 2024. The programme includes remote work on research projects, lectures and excursions online. The number of programme participants has reached 416 since 2020.

START Programme

In 2024, 85 representatives from Armenia, Belarus, Bolivia, Cuba, Egypt, India, Kazakhstan, Mexico, RSA, Russia, Serbia, and Uzbekistan participated in the winter and summer sessions of the START (STudent Advanced Research Training at JINR) programme carrying out research projects in person under the supervision of JINR staff for 6–8 weeks. In total, 459 people have taken part in the programme since 2014.

International Student Practice

In 2024, 73 students from Armenia, Belarus, Egypt, Kazakhstan, Mexico, Serbia, RSA, and Vietnam participated in three stages of the International Student Practice. The programme has been held since 2004, with a total of 1873 participants.

RSA–JINR Summer School

From 15 January to 2 February, the Republic of South Africa (RSA) hosted a three-week RSA–JINR Summer School for the fifth time. Students from three South African universities gathered at iThemba LABS. Ten JINR delegates from VBLHEP, FLNR, FLNP, and UC visited Cape Town to deliver lectures, seminars, workshops, and JINR exhibition activities. Multimedia JINR Exhibition was presented in the main hall of iThemba LABS. The Summer School students and iThemba LABS staff were given an overview of the main facilities of JINR and used VR technology to examine the corners of the NICA Accelerator Complex and see the construction of the Neutrino Telescope at Lake Baikal in detail. The programme also included excursions around iThemba LABS and students' presentations.

Rosatom Scientific School on New Materials and Technologies for Advanced Energy Systems

On 21–24 October, the second module of the specialized Scientific School "New Materials and Technologies for Advanced Energy Systems" for young scientists was held at the JINR International Conference Hall. The autumn stage of the educational programme was devoted to studying the basics of the synthesis of superheavy elements and the behaviour of materials in extreme conditions. More than 40 specialists from 17 Rosatom enterprises took part in the programme. The event was organized by the State Atomic Energy Corporation of the Russian Federation "Rosatom" with the support of JINR.

Science Intensive School

On 22–26 November, 30 undergraduate students from MSU, MIPT, MEPhI, Voronezh State University, Saint Petersburg State University, and Dubna State

Dubna, April. Participants of the START programme at the JINR Basic Facilities Exhibition

RSA, February. JINR delegation during a visit to universities in RSA to discuss cooperation

University participated in the School on Physics of Quark–Gluon Matter, held in Dubna within the preparation for experiments to test the fundamentals of quantum chromodynamics at the mega-science facility — the NICA hadron collider.

Element 105 Physics Workshop

On 5 July – 5 August, the Element 105 Physics Workshop was held as part of the 21st Summer School. The organizers included employees of JINR UC, LRB, DLNP, and VBLHEP. The participants were students from MSU, MIPT, MEPhI, Saint Petersburg State University, and universities of Tula and Novosibirsk. Most of students were majoring in physics, radiobiology, mathematics, and IT. The Workshop included lectures on neutrino physics, medical physics, charged particle accelerators, the use of neutrons in ecology, ionizing radiation in space, neural networks, etc. Excursions to the JINR basic facilities were organized for the School participants.

Practical Training for Students

In 2024, 83 students from Russia (representing Dubna State University, FEFU, Saint Petersburg State University, MEPhI), Kenya, Mexico, Poland, RSA, Serbia, and Vietnam participated in practical training sessions at JINR UC. Programmes are constantly updated and improved, the number of work stations is planned to be increased.

JINR Information Centres

In Tunisia, on 4, 22 April and 4 June, with the support of the Tunisian Society of Women Nuclear Scientists "Women in Nuclear Tunisia", scientific events were held at the JINR Information Centre established in 2023 at the headquarters of the Arab Atomic Energy Agency (AAEA). Within the framework of the events, JINR employees gave lectures on life sciences. The events sparked interest, and one of the webinars was attended by a large number of listeners from Tunisia, Libya, Egypt, Yemen, Syria, Iraq, Jordan, and other countries — about 60 participants in Zoom and about 400 on the social network.

On 9 December, a new JINR Information Centre was established at the iThemba LABS research laboratory in the Republic of South Africa. This marks the 12th JINR Information Centre. The opening ceremony was attended by heads of universities and research centres from RSA and JINR partner countries. The programme of the event also included a seminar on attracting young people to science with the participation of representatives of the Information Centres of Almaty, Irkutsk, Vladikavkaz, as well as Dubna State University management. The centre at iThemba LABS will contribute to the further development and implementation of personnel training programmes within joint projects and will foster the creation of new tools to engage young people in science.

Educational Issues and JINR Programmes for Training Personnel at International Meetings

Reports on personnel training programmes, mutual visits and opportunities for students and young scientists, as well as the development of a partnership network were presented at the following international meetings, conferences and schools:

- Round Table "International Aspects of Personnel Training for Large Scientific Projects" within the XXXI International Conference "Mathematics. Computing. Education" (Dubna) (23 January);

- Meeting with representatives of universities of the Republic of Azerbaijan (Dubna) (23–24 January);
- International School on Nuclear Methods and Applied Research in Environmental, Material and Life Sciences (NUMAR-2024) (Varadero, Cuba) (25–28 February);
- Meeting of representatives of JINR Directorate, heads of UC, FLNP, LRB, MLIT with a delegation from Brazil headed by the State Secretary for Policy and Strategic Programmes of the Ministry of Science, Technology and Innovation of Brazil (Dubna) (28 February);
- JINR–Cuba Applied Research and Human Development Meeting (Havana, Cuba) (1 March);
- International Training Programme for Administrative and Scientific Personnel (JEMS-24) (Dubna) (11–15 March);
- Round Table "International Scientific and Technological Cooperation in the New Conditions" within the XI International Forum "Technoprom-2024" (Novosibirsk) (27 August);
- 13th International Conference on Photonics and Applications, as well as working meetings and round tables in scientific and educational centres in Hanoi and Ho Chi Minh City (Vietnam) (13–19 October);
- IV Congress of Young Scientists (Sirius Federal Territory) (27–29 November).

Collaboration with Universities

On 1 March, JINR Directorate, heads of UC, MLIT, VBLHEP and the Bauman Moscow State Technical University (MSTU) discussed the expansion of scientific cooperation. Projects in the field of vacuum and cryogenic systems and process automation were considered as promising areas. Among other topics of the meeting were the possibility of MSTU students and postgraduates to participate in conferences and schools held at JINR, in the Institute's career guidance events, as well as the defense of qualification papers by MSTU students under the scientific supervision of JINR scientists.

On 3–6 March, representatives of UC, MLIT, VBLHEP visited Tomsk Polytechnic University within the framework of cooperation in the field of training personnel for mega-installations in Russia and career guidance activities for school students. The events were organized by the JINR Information Centre, established at Tomsk Polytechnic University in 2022. The programme included a presentation of a new educational and methodological complex for advanced physics course in schools, open lectures for students, meetings with Master's and PhD students, University faculty, as well as school students and teachers.

On 8 April, a delegation from Kamchatka State University named after Vitus Bering visited JINR. During the meeting with representatives of the Directorate and the University Centre, discussions were focused on scientific collaboration and the development of new joint educational programmes. As part of the visit, the guests toured scientific facilities at JINR Laboratories and attended the engineering workshop at the University Centre.

On 29 July, representatives of the Primorsky Krai Government and the Directorate of JINR, the University Centre, and MLIT discussed various aspects of developing cooperation in training highly qualified specialists. The parties focused on the further expansion of collaboration between Primorsky Krai and JINR across a wide range of areas, including opportunities for school students and university students, as well as professional development for school teachers. The JINR Information Centre, established in 2022 at Far Eastern Federal University, serves as the main entry point for school students, university students, and teachers from Primorsky Krai to engage with JINR.

Career Guidance Activities

Together with representatives of JINR Laboratories, UC staff participated in organizing exhibitions and lectures at various events:

- Day of Science (7–9 February);
- High technology and entrepreneurship week (18–24 March);
- Career Day at the Faculty of Physics at MSU (11 April);
- Job Fair "Work in Russia: Time of Opportunities" at Dubna SEZ (11 April);
- Open Day at MIPT (14 April);
- "On Your Marks" Career Fair at MEPhI (25 April);
- Dubna — city of professions (1 June);
- Science Cities Day: Exhibition of Dubna enterprises' achievements (14 June);
- MIPT Career Day (7 June);
- World of science and wonders (1 September);
- All-Russian Science Festival "NAUKA 0+" in Moscow (Zaryadye Park and MSU Library) (11–13 October);
- Open Day of MIPT's Department of Fundamental and Applied Problems of Microworld Physics (3 November);
- Regional career guidance event for secondary school graduates at Dubna SEZ (27 November);
- Career Day at the Faculty of Physics at MSU (28 November).

Scientific Schools for Physics Teachers at JINR in 2024

The following scientific schools took place:

- School for physics teachers from Irkutsk, Voronezh and Saratov Regions (25–29 March);
- Scientific school for physics teachers from various regions of Russia (Arkhangelsk, Irkutsk, Kaluga, Novosibirsk, Orenburg, Samara, Saratov and Ulyanovsk Regions, Yamalo-Nenets Autonomous Okrug, Bashkortostan, Crimea, Udmurtia, as well as Saint Petersburg and Stavropol) (8–12 July);
- School for physics teachers from Rosatom-partner cities (28 October – 1 November);
- First scientific school for physics teachers of the Republic of Belarus (2–6 December).

The programmes included introductory lectures, excursions, masterclasses, and an introduction to the textbook "Physics for Grades 7–9. Engineers of the Future".

Activities for School Students. Interaction with Educational Institutions of the City

Several educational initiatives operate in Dubna with the support of the Joint Institute for Nuclear Research: Physics and Mathematics Open Classroom, UC Physics Workshop, and Yandex Lyceum.

In mid-June, the Yandex Lyceum celebrated its fourth graduation event, with over 50 students completing the full two-year programme. The Lyceum has been running in Dubna since 2019 with JINR's active support, and 2024 marked the sixth enrolment of new students. Since its launch, the Lyceum has been supervised by the University Centre.

In the 2024/25 academic year, the Physics and Mathematics Open Classroom is offering physics and mathematics courses for students in grades 5–10.

Scientific Schools for High School Students

In 2024, there were held:

- Scientific and engineering intensive school for high school students from Tomsk (Dubna) (24–26 June);
- 36th International Computer School (ICS) (Ratmino) (5–17 July);
- VIII Summer School "Physics. Mathematics. Informatics" at Dubna State University (Dubna) (7–17 July);
- 4th Science School for Students of the Children's University at the Academy of Scientific Research and Technology of Egypt (Dubna) (10–14 September);
- International scientific school for high school students from Dubna and Astana (Kazakhstan) (Dubna) (18–22 November).

The programmes included lectures, excursions, and workshops.

Physics Days 2024

On 1 June, in collaboration with young scientists from JINR AYSS, the University Centre organized the traditional Science Festival "Physics Days" in Dubna.

25–29 March. Scientific school for physics teachers of Irkutsk, Voronezh and Saratov Regions

The Veksler and Baldin Laboratory of High Energy Physics, 24 June.
Students of the Tomsk Zaozernaya school on a guided excursion to the Laboratory

Dubna, 10–14 September. 4th Science School for Students of the Children's University of the Egyptian Academy of Scientific Research and Technology.
On an excursion to VBLHEP

Over 85 students in grades 4–9 were in attendance. The programme included experiments, demonstrations, and workshops across various fields of physics, showcasing devices based on physical laws. The Festival took place at two venues: Lyceum No. 6 named after G. Flerov and the University Centre building.

Open Robotics CyberDubna Tournament

On 13 April, the University Centre organized the 13th Open Regional Robotics Tournament "CyberDubna" at the Kadyshevsky Physics and Mathematics Lyceum. The event brought together 14 teams from Dmitrov, Dolgoprudny, Dubna, Protvino, Saint Petersburg, and Zaprudnya. During a roundtable discussion, team mentors and supplementary education tutors explored opportunities to expand the network of educational technical hackathons to attract more participants. They also outlined an activity plan for the upcoming academic year, making use of various venues across the Moscow Region.

Technical Hackathon

On 24–25 February, the University Centre hosted the 7th Technical Hackathon "Dubna 2024", jointly

organized with the Kadyshevsky Physics and Mathematics Lyceum and Dubna University College. Thirty-eight students in grades 5–10 and first-year college students from Dmitrov, Dubna, Serpukhov, and Zaprudnya, took part in the event. The programme included educational workshops, independent tasks in R&D, design, and programming, as well as various thematic competitions.

On 22–23 November, preliminary rounds of the Technical Hackathon "Dubna 2025" for beginners in basic robotics were held. Seventeen teams from schools in northern Moscow Region participated, including those from Dmitrov, Dubna, Sergiyev Posad, Taldom, and Verbilki.

Visits

Sixty-four excursions and 31 lectures were organized for JINR Information Centres and school and university students — online and in-person — as part of career guidance activities.

TRAINING SPECIALISTS AND PROFESSIONAL DEVELOPMENT

The University Centre's engineering workshop is now systematically used for the professional development of JINR Laboratory staff, with the initial participants being young professionals from the Institute's Member States.

In the 2024/25 academic year, 92 JINR staff members take English language courses at the University Centre.

In November, the Russian Conversation Club at the University Centre opened its doors. The first participants included 29 representatives from China, Cuba, the Czech Republic, Egypt, India, Mongolia, Romania, RSA, and Vietnam. The Club's daily meetings cover such topics as etiquette norms, life and challenges, and an introduction to Russian culture and traditions.

Fifty students from Dubna University College, MEPhI College, and Dmitrov Technical School completed internships at JINR.

September. Presentation of a new educational and methodological complex in physics for schoolchildren "Physics for Grades 7–9. Engineers of the Future"

INNOVATIVE ACTIVITY

INNOVATIVE ACTIVITY

RESEARCH AND DEVELOPMENT

In 2024, the establishment of the Innovative Centre for Nuclear Physics Research in the fields of life sciences, biomedical technologies, radiation biology, radiation materials science, ecology, and information systems continued at the Joint Institute for Nuclear Research. Within this initiative, a specialized user infrastructure is being formed around JINR's existing unique facilities for specialists from the Member States working on applied tasks and developing new technologies. New facilities with significant innovation potential are being created.

At the **Veksler and Baldin Laboratory of High Energy Physics (VBLHEP)**, with the completion of the magnet system assembly and the establishment of the relevant engineering infrastructure for beam delivery and flexible beam control to be used at the new stations for applied research — ISCRA (Irradiation Station of Components of Radioelectronic Apparatus) and SIMBO (Station for Investigation of Medical Biological Objects), the area for applied research based on extracted beams of the NICA accelerator complex (ARIADNA: life sciences, biomedical applications, studies of radiation hardness of semiconductor electronics, nuclear physics data for advanced energy systems, beams with energies from MeV/nucleon to GeV/nucleon) has been fully prepared for operation.

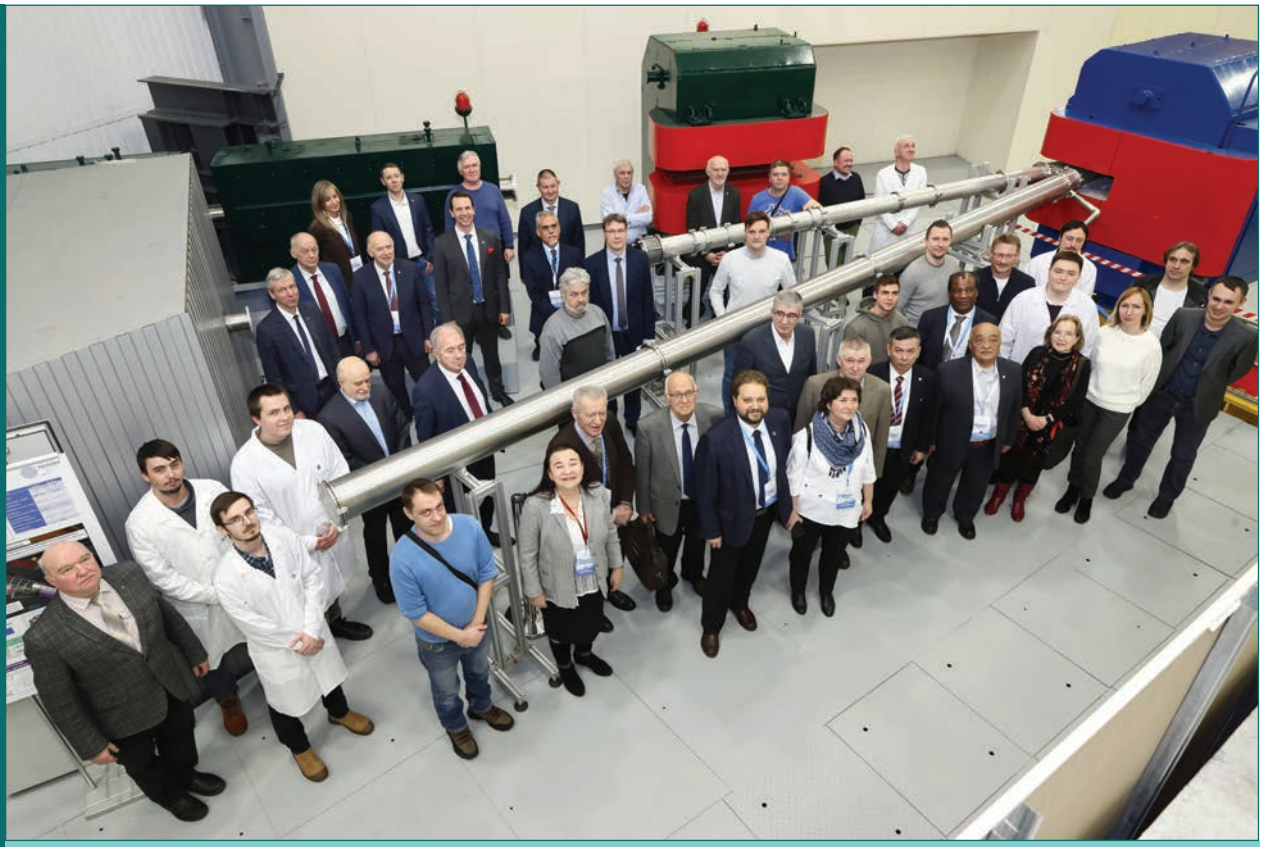
Work continues on the development of auxiliary equipment for the applied research area, detector and dosimetric systems, and the creation of a dedicated laboratory of IBMP RAS for joint projects in the fields of space biology and medicine, the study of radiation shielding properties of spacecraft materials, and radiobiological research on laboratory animals.

Within the ARIADNA collaboration (four new organizations from Russia, Belarus, and Uzbekistan joined the collaboration in 2024), a series of scientific and methodological works were carried out in the fields of life sciences and radiation materials science. To enhance the efficiency of detecting DNA double-strand breaks (the most serious damage induced by accelerated ions), a method for the rapid assessment of the number of foci of DNA repair proteins *γ*-H2AX and phosphorylated ATM (pATM) in irradiated cells was developed jointly with the Burnazyan FMBC. In radiation materials science, in cooperation with FRC CP RAS, optical spectroscopy and diffuse and specular reflection spectroscopy methods were used to study the optical characteristics of thermoradiation-modified polytetrafluoroethylene (TRM-PTFE) films of 100 μm thickness, which had been irradiated by xenon ions at 3.2 MeV/nucleon and protons at 260 MeV.

At SOChI (Station Of Chip Irradiation, ARIADNA), five irradiation sessions of decapsulated microchips were performed. Six types of microchips were irradiated to study the effect of the pulsed beam structure on electronic component bases. The station's diagnostic equipment was upgraded to reliably determine the primary parameters of ion beams and ion fluxes on the target.

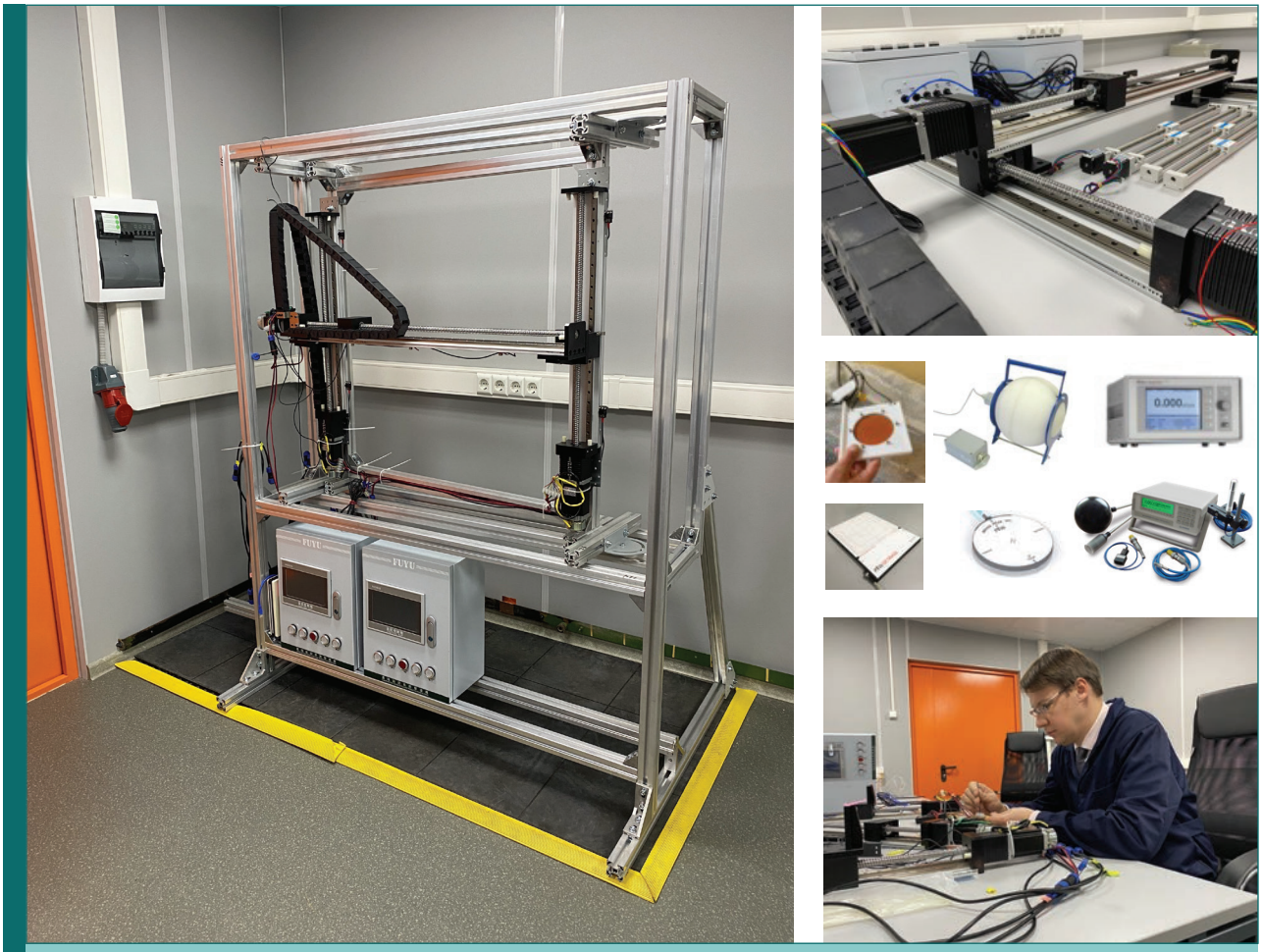
Work continued on HTS (High-Temperature Superconductivity) technology: a pilot magnet was developed with a winding made of HTS cable designed to operate at 50 K, and a machine to manufacture a Nuclotron-type cable from high-temperature superconductor was produced and put into operation.

The **Dzhelepov Laboratory of Nuclear Problems (DLNP)** has prepared the launch of a new JINR basic facility with high potential for use in applied and innovation projects, notably in radiation materials science, radiobiology, and radiochemistry — the Linac-800 facility based on an electron accelerator, which will provide beams in a broad energy range from 24 to 800 MeV for experiments. The development and installation of the accelerator's safety systems — ARMS (Automated Radiation Monitoring Systems) and ICS (Interlock Control Systems) for Linac-800 — have been completed. Three extraction lines for energies of 24, 133.5, and 207 MeV have been implemented. Preparation of magnets and vacuum chambers is nearing completion for the 60 MeV extraction line.



The Veksler and Baldin Laboratory of High Energy Physics, February.
Inauguration of the stations for applied research at NICA under the ARIADNA project

The Veksler and Baldin Laboratory of High Energy Physics.
Beam transport channels in the applied research area



Assembly of the modernized ARIADNA target station for long-term radiation exposure

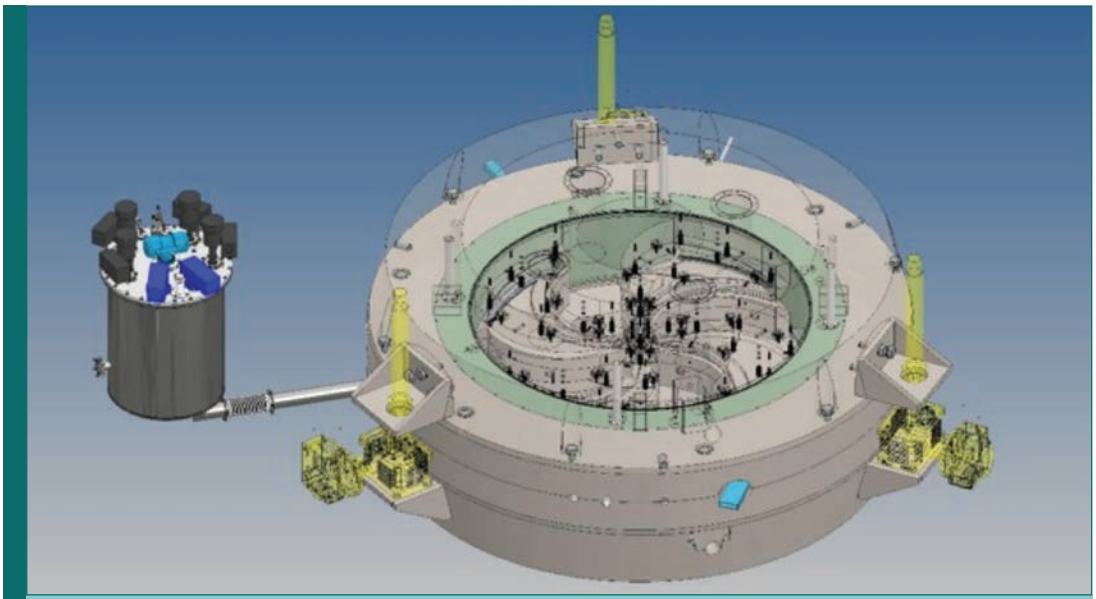


Fig. 1. 3D model of the MSC-230 cyclotron

As part of the development of the medical superconducting cyclotron MSC-230 (Fig. 1), designed for proton beam therapy and medical and biological research, calculations were made for the characteristics of the electromagnet, resonance system, proton beam dynamics in the acceleration and extraction zone of the cyclotron, and the design and manufacture of the helium refrigerator were completed. The technical design of the cyclotron systems and the preparation of the infrastructure for cryogenic testing of the superconducting solenoid are ongoing.

At the **Centre of Applied Physics of the Flerov Laboratory of Nuclear Reactions (CAP FLNR)**, new exploratory research and development activities aimed at creating products and technologies based on track membranes are underway. A preparative tangential filtration system has been created for rapid micro-, ultra-, and diafiltration of samples (culture media, blood plasma, buffer, and other solutions) (Fig. 2). The unique technology developed at the CAP for producing porous structures with a controlled degree of anisotropy in polyester films allows researchers to orient microcapillaries in the polymer matrix in a predefined way, accurately specify the radius of these capillaries, and control the volumetric porosity. This opens up possibilities for producing track membranes with a preferred orientation of the pores, ensuring a preferential direction for fluid front flow.

This result provides a starting point for creating immunochromatographic test strips for simple, rapid, and low-cost preliminary diagnosis of diseases or physiological conditions using "point-of-care" technology.

Jointly with NMRC Endocrinology, research continues aimed at developing an implantable bioreactor for subsequent loading with tissue-engineered material and culture medium in order to assess the applicability of track membranes for constructing a tissue-engineered structure of the pancreas containing various insulin-producing cells.

Work with innovation-driven companies, including residents of the Special Economic Zone (SEZ) "Dubna", also continued. At the CAP FLNR, a project is underway to develop new materials for hydrogen energy and to overcome the drawbacks of existing commercial proton-conducting membranes. This project examines the feasibility of creating hybrid membranes based on modified fluorinated films to be used as proton-conducting membranes in hydrogen-air and methanol fuel cells. For dental applications, a bone graft material (barrier membrane) is being developed, using track membranes covered by a layer of collagen applied via electrospinning. Joint experiments with an industrial partner continued on the use of microtiter plates produced using ion-track technologies, as well as on a modified track membrane (developed together with specialists from the Sector of Molecular Genetics at the Laboratory of Radiation Biology) that can selectively accumulate DNA macromolecules. A promising application of these developments is laboratory diagnostics of bacterial resistance to antimicrobial drugs.

In collaboration with a partner from SEZ "Dubna," research continues at the **Frank Laboratory of Neutron Physics (FLNP)** and the **CAP FLNR** on the creation of affordable, bioinspired corneal grafts suitable for long-term storage, able to be used for the main types of keratoplasty, and having a high level of biocompatibility — expected to serve as a complete replacement for donor human corneal tissue in ophthalmology. In optimizing the parameters of this developing method, data were used from small-angle X-ray scattering (MURR — Medical University of Radiological Research — station for USAXS/SAXS/WAXS XEUSS 3.0).

Within the TANGRA project collaboration, scientists from **FLNP** and **VBLHEP**, in cooperation with an industrial partner and specialized institutes, continue work on creating a mobile facility and developing a method to determine soil carbon content for use in monitoring greenhouse gas emissions and absorption, climate projects, and more environmen-

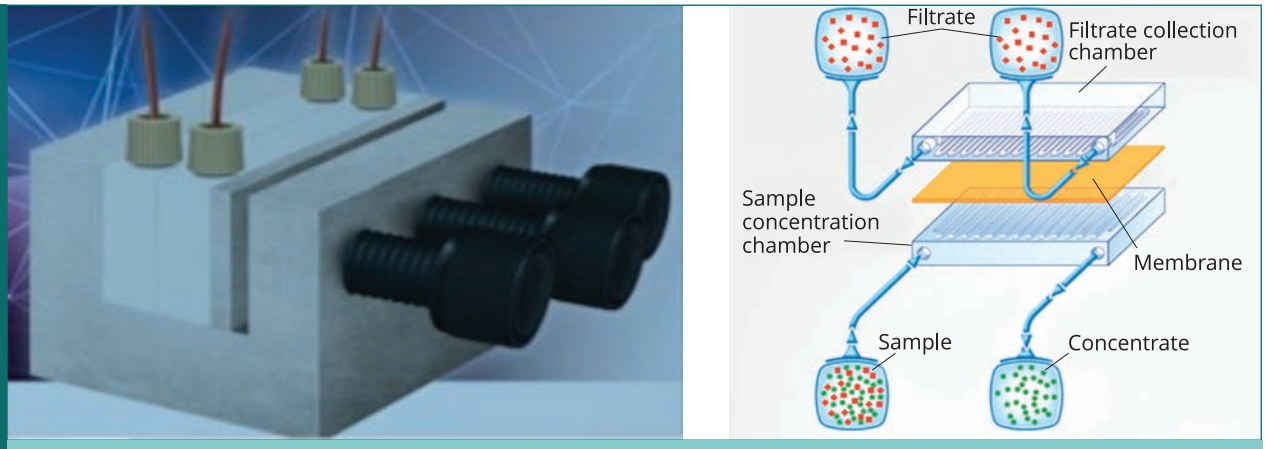


Fig. 2. A preparative tangential filtration system for R&D and biotechnologies (CAP FLNR)

A scanner based on labeled neutrons (FLNP and Diamant) on an unmanned transport platform created at Dubna University

tally friendly agro-industrial technologies. Joint experiments have been carried out with experts from relevant climate and agricultural testing sites to use the JINR-developed scanner based on the tagged neutron method in the field, employing different unmanned transport platforms, including a platform developed by Dubna State University.

At DLNP, as part of the project "New Semiconductor Detectors for Fundamental and Applied Research," the development continues of a semiconductor pixel energy-sensitive detector operating in single-photon counting mode (SPC detectors). Major application areas of such detectors include computed tomography (CT) for medical diagnostics, as well as non-destructive testing of finished products in industry.

The key component of the SPC detector is a pixel chip (ASIC). The design of JINR's own ASIC, called JIMed, is being carried out at DLNP jointly with colleagues from INP. In 2024, the analog amplifier section of JIMed was submitted for production at JSC Mikron (Zelenograd) under an MPW test project.

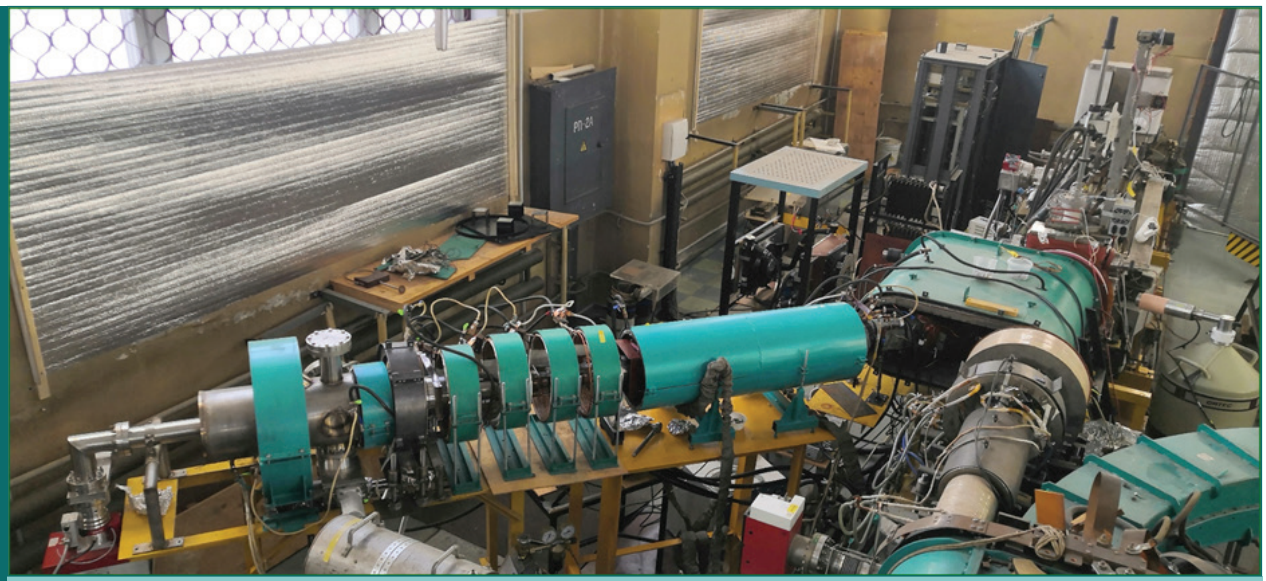
A joint research effort with MSU is underway to develop and study oxide nanoparticles (Ln_2O_3, Gd_2O_3) and their composites (CA) for new imaging techniques in medicine. New methods for identifying CA in CT have been developed, allowing for the detection and measurement of CA concentrations from 0.1 mg/ml.

At the DLNP Experimental Department of Nuclear Spectroscopy and Radiochemistry, a neutron counter was developed to measure fluxes at the level of 10^{-6} cm$^{-2} \cdot$ s^{-1}, and patent No. 226117 "Compact Low-Background Helium-3-Based Neutron Counter" was obtained. For the search for the neutrinoless double-β decay of ^{130}Te, a polystyrene-based scintillator was developed with a diphenyltellurium oxide complex and di-(2-ethylhexyl)phosphoric acid. The light yield (for 1% metal content) of the samples relative to standard plastic is 60%. Accelerated climate testing predicted a lifetime of the scintillator to be about four years (until the light yield is reduced by 10%).

Participants of the project from Russia, Bulgaria, Azerbaijan and South Africa have launched a mass spectrometer (MS-ICP). The yields of ^{59}Co(γ, xn)$^{55-58}$Co, $^{52-56}$Mn, ^{49,51}Cr reactions using Linac-200 braking radiation at an electron energy of 40−130 MeV have been determined. The ratio of yields for the $^{52m/52g}$Mn isomeric pair in the range of 80−130 MeV has been measured for the first time. The calculated cross sections according to the TALYS-1.96 program turned out to be in agreement with the experimental data.

Within the project "Precision Laser Metrology for Accelerators and Detector Complexes," inclinometers were used to monitor the "balconies" used for beam extraction in the MPD hall of the NICA collider. An experiment was performed to determine the nat-

Dubna, 10–20 September. Delegation from Vietnam — participants of the Workshop on Accelerator Technologies at the Linac-200 facility at DLNP



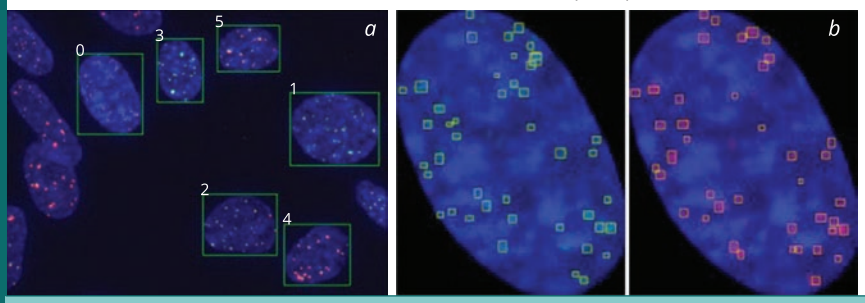
Positron Annihilation Spectroscopy (PAS) facility

ural vibration frequencies of the "balcony," yielding frequencies of 2.5, 5, 7.5, and 9 Hz.

During 2024, work continued on a new type of precision laser inclinometer — an Interferometric Precision Laser Inclinometer (IPLI). Its operating principle relies on patented technical solutions. A prototype was created to investigate the temperature stability of the IPLI, the influence of laser power, and the necessity of vacuum conditions. The main objective is to develop an inclinometer that is simpler and more reliable than the MPLI, with fewer readout channels, more compact dimensions, and operation in a lower frequency range.

In 2024, within the project "Development of Experimental Techniques and Applied Research Using Monoenergetic Positron Beams (PAS)" at DLNP, an ion source, designed to bleed thin layers of material from samples, was installed and tested.

In addition to the DBAL (Doppler Broadening of the Annihilation Line) method on the positron beam,



The number of RIF in the nuclei of individual cells

Cell_name	Red_Foci	Green_Foci
00	41	44
01	17	45
02	30	33
03	22	20
04	21	23
05	18	18

Name	Average
Red-Foci	24.833333
Green-Foci	30.5

Fig. 3. Step-by-step analysis of fluorescent images of normal human skin fibroblast nuclei in the MOSTLIT application: *a*) cell nucleus recognition, *b*) RIF recognition (*γ*H2AX and 53BP1 markers), *c*) quantitative RIF analysis

a coincidence DBAL method has been launched, enabling highly accurate investigation of defect structures and their chemical environment. Applying these two methods allows the study of defect concentration and distribution in materials, analysis of alloys, nanostructures, thin-film coatings, characterization of materials used in electronics, catalysis, and nuclear energy, as well as investigation of defect environments for studying the chemical composition of materials.

In cooperation between the **Laboratory of Radiation Biology** and the **Meshcheryakov Laboratory of Information Technologies**, development of the MOSTLIT application continues for analyzing fluorescent images of radiation-induced foci (RIF) obtained by the immunocytochemistry method (Fig. 3). A neural network-based approach has been developed for the automatic analysis and counting of RIF in the nuclei of normal human fibroblasts. The automatically obtained counting data using the MOSTLIT algorithm correlate well with results from operator-based image analysis. The service is available at mostlit.jinr.ru.

Within the joint research project with the Institute of Microbiology (Sofia, Bulgaria), the patterns of induced antibiotic-resistance mutations in yeast and bacterial probiotic strains were studied. The high radioresistance and low mutability of the probiotic preparations tested indicate their potential for use in space flight conditions.

A program was created to predict radiation damage to nerve cells with a detailed description of the sub-neuronal target, track structure, and radiolysis mechanism. The program can model the geometry of nerve cells, including the spatial organization of numerous dendritic spines, combining it with the track structure model at the physical and radiation-chemical stages. The result of the program's operation is a highly accurate prediction of the absorbed dose and the probability of particles hitting different parts of the cell (soma, axon, dendrites, spines) when exposed to accelerated particles over a wide range of energies.

A software-based mathematical model of a Galactic Cosmic Ray (GCR) simulator has been implemented — this special facility can potentially generate a mixed ionizing radiation field from a beam of relativistic heavy nuclei to simulate space radiation conditions. The further plan is to build and test a prototype GCR simulator within the NICA complex at SIMBO to conduct radiobiological experiments in radiation fields that mimic space radiation.

A computational model of a neutron dosimeter with a heterogeneous moderator and a helium counter was created using the MCNP code to measure the ambient dose of neutrons over a wide energy range, from thermal to high-energy (10^{-9} MeV to 1 GeV). The software is designed to reconstruct neutron spectra at nuclear physics facilities by a method of statistical regularization using data from Bonner sphere detectors. The program input includes detector readings, energy response functions, a list of the detectors used, and prior information on the maximum neutron energy.

To create innovative products based on JINR's research infrastructure and competencies and to foster international, cross-laboratory, and interdisciplinary initiatives relevant to the technological agendas of the Member States, a competition of innovative developments by young JINR scientists has been prepared. This competition will offer annual support to 5–10 youth development teams from the JINR Member States.

An information resource on JINR detector technologies, the so-called Detector Centre, has been created, and an interactive application has been developed to collect and visualize such databases at JINR. The same approach is being applied to accelerator technologies, resulting in the Accelerator Centre database. These databases are filled by interlaboratory youth teams of the Institute. Through SSO, contextual searches are available for information on the equipment in the Institute's Laboratories, usage experience of various components and materials, and in-house competencies for designing modern detectors and for developing and operating particle accelerators.

To align with the legislation of the JINR host country on remuneration procedures for authors of official intellectual property results, a new Regulation was prepared and enacted concerning the amounts and payment procedures for remuneration for official intellectual property results, in close cooperation with the laboratories and relevant administrative units.

INTELLECTUAL PROPERTY PROTECTION

JINR's Innovations and Intellectual Property Department (IIPD) continued to interact with the Federal Institute of Industrial Property (FIIP) of Rospatent (Russian Federal Service for Intellectual Property) regarding JINR patent applications that passed FIIP's formal examination in 2023–2024. To assess the patentability of JINR employees' new developments, an expert evaluation was carried out to identify objects of legal protection, classify them according to the International Patent Classification (IPC), and search for equivalents and prototypes. Patent research reports were prepared in collaboration with laboratory staff.

For nine developments, together with the inventors, sets of application documents were prepared and submitted to the Russian Patent Office (Rospatent) to obtain invention patents.

Seven patents of the Russian Federation were obtained for inventions and utility models:

— (RU) 2813557 "Position-Sensitive Detector of Thermal and Cold Neutrons Based on a Parallel-Plate Resistive Chamber" by M. Petrova, A. Bogdzel, V. Bodnarchuk, O. Daulbaev, V. Milkov, A. Kurilkin, K. Bulatov, A. Dmitriev, V. Babkin, M. Rumyantsev;

— (RU) 2814514 "Semiconductor Avalanche Detector" by Z. Sadygov, N. Zamyatin, R. Akberov, T. Bokova, F. Akhmadov, A. Sadygov;

— (RU) 2816244 "Position-Sensitive Radiation Detector of Thermal and Cold Neutrons from a Compact Investigated Sample" by A. Kolesnikov, B. Zalikhanov, V. Bodnarchuk;

— (RU) 2816242 "Method for Assembling Supermodules for Ionizing Radiation Detection" by V. Elsha, D. Dementiev, A. Sheremetyev, A. Voronin, Yu. Murin;

— (RU) 226117 "Compact Low-Background Helium-3-Based Neutron Counter" by S. Evseev, A. Emelyanov, I. Kamnev, S. Rozov, E. Yakushev;

— (RU) 2828765 "Method for Cooling a Neutron Beam and the Device for Its Implementation" by S. Dolya;

— (RU) 2832195 "Method for Manufacturing a Joint of High-Temperature Superconducting Cables" by A. Shemchuk, M. Novikov, M. Ilyin.

Additionally, at year-end, a positive decision was issued by Rospatent on application No. 2024112102 "Method of Pulsed Injection and Trapping of Neutrons in a Ring Neutron Accumulator" by Yu. Nikitenko, E. Kolupaev, V. Zhuravlyov.

In the Register of Programs for Electronic Computers of Rospatent, twelve software programs were registered:

— 2024612337 "View_KEE_KSH Remote Key Control Software for Energy Evacuation of the Collider" by A. Panfilov, R. Akhmadrizyalov, V. Karpinsky, S. Kirov, A. Kopchenov, A. Sergeev;

— 2024616778 "Software for Generating Control Signals for Power Supplies at the Superconducting Magnet Test Stand" by N. Blinov, V. Karpinsky, A. Zorin;

— 2024618617 "Software for Visualizing Data from a Computer Model of an Irradiation Setup That Imitates a Mixed Radiation Field at Charged Particle Accelerators" by I. Gordeev;

— 2024681268 "Software for Predicting Radiation Damage to Nerve Cells with Detailed Description of the Sub-Neuronal Target, Track Structure, and Radiolysis Mechanism" by Munhbaatar Batmunh, Lhagvaa Bayarchimeg;

— 2024611065 "Intelligent Coordination System Control Based on Quantum Fuzzy Output for Tango Controls" by P. Zrelov, M. Katulin, A. Reshetnikov, S. Ulyanov;

— 2024611064 "RECONST Software for Reconstructing Neutron Spectra Based on Bonner Spectrometer Readings" by L. Beskrovnaya;

— 2024661482 "Neutron Activation Analysis on the REGATA Facility of the IBR-2 Reactor" by D. Grozdov, V. Galustov;

— 2024661642 "Software for Calculating Primary Galactic Cosmic Ray Spectra under Different Solar Activity Conditions (GCRs Spectra)" by I. Gordeev;

— 2024661481 "Software for Operating the Pneumatic Transport System at the REGATA Facility of the IBR-2 Reactor" by D. Grozdov;

— 2024666033 "Software for Registration of Applications for Foreign Employees Invited to JINR by the Institute's Laboratories" by V. Eliseev, I. Zhuravlyova;

— 2024666184 "Software for Direct Access to the Registration Tables of Travel Documents" by V. Eliseev;

— 2024690973 "Software for the Visualization and Accounting of an Organization's Technologies and Competencies" by A. Ilyina, I. Pelevanyuk.

In 2024, 72 JINR patents remained in force. Work proceeded with the laboratories to identify patents having a priority date older than ten years that no longer require extended support. As for patent-information activities, JINR electronically received

36 issues of the Rospatent bulletin “Inventions. Utility Models” during 2024.

Information notices by the IIPD about new patents and other state registrations of industrial intellectual property (software, databases, and TIC — Topology of Integrated Circuits) are being prepared. This information is regularly published in the “Patents” section on the JINR website (http://www.jinr.ru/posts/category/patents-ru/) and in the “Active JINR Patents” (https://oliis.jinr.ru/index.php/patentovanie-2/8-russian/25-dejstvuyushchie-patenty-oiyai) and “Computer Programs Registered by JINR” (https://oliis.jinr.ru/index.php/patentovanie-2/8-russian/28-programmy) sections of the IIPD webpage.

INTERNATIONAL RELATIONS AND SCIENTIFIC COLLABORATION

COLLABORATION in SCIENCE and TECHNOLOGY

The main results of the international cooperation in science and technology of the Joint Institute for Nuclear Research in 2024 are reflected in the following data:

— joint research was conducted with scientific centres in the Member States, as well as with international and national organizations in other countries, on 77 projects and subprojects of the Topical Plan for JINR Research and International Cooperation;

— the Joint Institute sent 1580 specialists to solve cooperation issues and issues of participation in scientific meetings and conferences;

— 608 specialists were received for joint work and consultations, as well as for participation in meetings, conferences, and schools held at JINR;

— 70 international scientific conferences and schools, 16 workshops, and 13 meetings were organized and held.

The international cooperation of JINR is presented in agreements and treaties. Its development comprises joint experiments at basic facilities of physics centres, the acquisition of research data, the preparation of joint publications of the joint research results, the supply of equipment and techniques for the interested sides, etc.

From 14 to 18 January, a scientific symposium, held at the Du Kloof Lodge (RSA Western Cape Province), was attended by employees of DLNP JINR D. Zinatulina, A. Baimukhanova and M. Zarubin.

The scientific symposium was dedicated to the creation of an underground low-background laboratory PAUL (Paarl Africa Underground Laboratory) under the Du Toitskloof Mountains (1300 m) in the middle of an existing 3.9-km-long auxiliary tunnel, which will allow achieving a rock shielding material thickness of about 800 m. The laboratory will be the first specialized deep underground low-background laboratory in Africa and the second in the Southern Hemisphere. The key tasks of the laboratory will be particle physics, astrophysics, nuclear physics, and interdisciplinary research in geology, geophysics, and biology. The JINR staff took part in the discussion of the implementation of the laboratory project, advanced research topics, and opportunities for cooperation.

On 23–24 January, JINR hosted a visit by representatives of universities of the Republic of Azerbaijan. The delegation, headed by the founder of Khazar University (Baku) H. Isayev, visited laboratories of the Joint Institute, met with the JINR Directorate, and took part in a review seminar at the Dzhelepov Laboratory of Nuclear Problems.

At the meeting at the JINR Directorate, the parties discussed opportunities to develop JINR–Azerbaijan cooperation, primarily in engineering, natural, and information sciences, theoretical and applied physics, chemistry, biology, nanotechnology, and mathematics.

At the review seminar organized at the Dzhelepov Laboratory of Nuclear Problems, the guests from Azerbaijan spoke about the main activities and research areas of Khazar University, aspects of international collaboration in science and education, and the university's partner organizations in the world. The delegation members mentioned the coordination of educational programmes and internships at JINR for the Uiversity's students from various countries. The guests also expressed interest in inviting JINR scientists to participate in the University's educational activities.

During the visit, the representatives of Azerbaijani universities reviewed JINR's research areas and facilities of the Institute's scientific infrastructure, held meetings with the leading scientists of JINR laboratories, and visited the JINR University Centre to learn more about the opportunities provided by the Institute in personnel training.

On 25 January, in the main building of the Lomonosov Moscow State University (MSU), as part of the grand meeting dedicated to the 269th anniversary of the University, MSU Rector V. Sadovnichy presented JINR Director G. Trubnikov with a diploma on awarding him the title "Honorary Professor of MSU" for his large contribution to the development of nuclear physics and elementary particle physics and for the long-standing fruitful cooperation with the Moscow University.

V. Sadovnichy stressed at the ceremony that the Joint Institute and Moscow State University had been cooperating since 1961. In 2022, a decision was made to establish an MSU branch in Dubna. In November 2023, a joint meeting of the MSU–JINR

Dubna, 23–24 January. Visit of representatives of universities of the Republic of Azerbaijan to JINR

Moscow, 25 January. MSU Rector V. Sadovnichy presents JINR Director G. Trubnikov with a diploma of Honorary Professor of MSU

Scientific Council took place. At the event, the scientific organizations signed a new agreement on cooperation.

On 25 January, JINR Director G. Trubnikov and young JINR scientists took part in the inauguration of a core centre of industrial medicine in Dubna via videoconference. The centre will coordinate the work of nine centres of industrial medicine of the Federal Medical and Biological Agency (FMBA) of Russia in other cities. The event was held online with the participation of Deputy Prime Minister of the Russian Federation T. Golikova and Head of FMBA of Russia V. Skvortsova.

The centres of industrial medicine will allow the staff of enterprises to have periodical health examination quickly and comfortably and receive medical care. In the science city of Dubna, such a centre is organized on the basis of Medical Unit No. 9 of FMBA of Russia, a subdivision of which is a digital health centre in the SEZ "Dubna".

On 29 January, JINR Director G. Trubnikov and iThemba LABS Director M. V. Tshivhase signed an agreement on the establishment of a JINR Information Centre at iThemba LABS (RSA).

The activities of the new Information Centre are aimed at informing the general public of the country

Dubna, 29 January. After signing of an agreement on the organization of the JINR Information Centre on the basis of iThemba LABS (RSA) by Director of iThemba LABS M. V. Tshivhase and JINR Director G. Trubnikov

about the results of international research achieved at JINR, including with the participation of South African scientists, as well as career guidance and attracting young people to science through scientific and educational events such as virtual tours of the Institute's basic facilities, lectures by scientists from Dubna, online laboratory exercises and workshops.

On 5 February, an agreement on the establishment of a consortium for IT support for megascience research infrastructure was signed. The grand ceremony took place in the Presidential Hall of the International Multimedia Press Centre "Russia Today" with the participation of Deputy Prime Minister of the Russian Federation D. Chernyshenko. JINR Director G. Trubnikov, President of the National Research Centre "Kurchatov Institute" M. Kovalchuk, and Director of the Ivannikov Institute for System Programming of the Russian Academy of Sciences H. Avetisyan signed the document.

The consortium aims to address the issue of uniting infrastructure and skills in the field of IT technologies in Russia to ensure the functioning and development of a national network of megascience research facilities and achieve breakthrough scientific results. In addition, the consortium will become the basic computing infrastructure for the National Genom Database and bioresource centres.

D. Chernyshenko stressed that the consortium will use the National Research Computer Network,

Moscow, 5 February. Signing of an agreement on establishment of a consortium for IT support for megascience research infrastructure. *Photo: © Media Bank RIA Novosti*

The Veksler and Baldin Laboratory of High Energy Physics, 13 February. Visit to the NICA accelerator complex by a delegation of the Embassy of the Republic of Sri Lanka in the Russian Federation headed by Ambassador Extraordinary and Plenipotentiary Professor J. Liyanage (2nd from left)

to which more than 80% of Russian scientific organizations are already connected.

On 13 February, a delegation of the Embassy of the Republic of Sri Lanka in the Russian Federation visited the NICA accelerator complex at the Joint Institute for Nuclear Research. The Ambassador Extraordinary and Plenipotentiary of the Republic of Sri Lanka to Russia, Professor J. Liyanage, headed the delegation.

The members of the delegation got acquainted with the progress in the implementation of the megascience project and learned about the NICA physical tasks in basic and applied research. The guests visited the main facilities of the NICA complex: the linear accelerator, the Booster, the collider tunnel, and the MPD. In particular, the delegation explored the SOChI irradiation station, learned more about the research programme at the experimental facility and the work of the ARIADNA collaboration on applied research at the NICA complex. VBLHEP JINR Scientific Secretary A. Cheplakov and Deputy Head of the VBLHEP Accelerator Department A. Sidorin conducted the tour for the guests.

On 16 February, the first award ceremony of the OGANESSON Prize took place. The Pushkin State Museum of Fine Arts in Moscow hosted the grand event. Representatives of scientific organizations and Russian ministries, cultural and art figures, and media workers gathered in one of the world's leading museums to participate in this event.

JINR Director G. Trubnikov opened the ceremony and expressed gratitude to the administration of the Pushkin Museum, the Ministry of Culture, the Ministry of Science and Higher Education, and the Ministry of Foreign Affairs of the Russian Federation for supporting the prize and assisting in organizing the event.

A. Sergeev, Chairperson of the jury of the Oganesson Prize, Scientific Leader of the Russian National Centre for Physics and Mathematics, gave a speech. He quoted the words of Academician A. Sakharov about the importance of scientific and technological progress through "the preservation of the humane in a human being and the natural in nature".

A. M. Cetto Kramis, a physics professor at the National Autonomous University of Mexico, received the prize for her outstanding scientific work in quantum mechanics and theoretical physics, and great personal contribution to the strengthening of global scientific cooperation for peace and sustainable development.

M. Shvydkoy, Doctor of Arts, Art Director of Moscow Musical Theatre, received the prize for his outstanding personal contribution to the development of international scientific and cultural cooperation and the popularization of modern science achievements in mass media.

The third laureate of the Oganesson Prize was V. Pershina, a chemistry professor at the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt (Germany). She was awarded for theoretical studies of the electronic structure and chemical properties of superheavy elements of the Mendeleev Periodic Table.

In the nomination for young laureates, Head of the Scientific and Experimental Department of the Accelerator Complex of the Flerov Laboratory of Nuclear Reactions at JINR V. Semin became the winner.

Moscow, 16 February. Winners of the Oganesson Prize at the first award ceremony at the Pushkin State Museum of Fine Arts

He received the prize for his significant personal contribution, made at the beginning of his scientific career, to the creation of new JINR basic experimental facilities that provide breakthrough scientific results in nuclear physics. V. Semin led the commissioning of the DC-280 cyclotron at the SHE Factory.

In the final part of the ceremony, Academician Yu. Oganessian, the founder of the award, gave a speech. He highlighted he was glad that the prize is awarded not only for scientific achievements, but also for the popularization of science. The award ceremony ended with a commemorative group photo of the laureates and founders of the award.

On 19–20 February, representatives of the State Scientific Centre — the Burnazyan Federal Medical Biophycical Centre and specialists of the Federal Scientific Clinical Centre of Medical Radiology and Oncology of the Federal Medical Biological Agency (FMBA) of Russia visited JINR. The aim of their visit was the discussion of prospects to organize a scientific-clinical centre of proton therapy in Dubna. RAS Academician, cancer surgeon I. Reshetov and General Director of the Federal Scientific Clinical Centre of Medical Radiology and Oncology of FMBA of Russia Yu. Udalov took part in the event in a remote format.

During the visit, a meeting was held where reports devoted to the establishment of a proton therapy centre in Dubna were presented. JINR Director Assistant on development of medical-biological projects G. Shirkov made a report "A scientific clinical centre of proton therapy in Dubna. The conceptual foundation". LRB Director A. Bugay presented a report on radiobiological research at proton beams. DLNP Chief Engineer S. Yakovenko reported on the status of implementation of the project "The medical superconducting cyclotron MSC-230". The report of Head of the Radiation Medicine and Biology Sector of DLNP G. Mitsyn was devoted to peculiarities of forming the beam for proton flash-therapy at the MSC-230 accelerator.

The results of the meeting were considered in a discussion, during which the participants talked about plans and further strategy of the proton therapy centre development in Dubna.

On 1 March, representatives of JINR and the Bauman Moscow State Technical University (MSTU) met in Dubna to discuss issues of widening scientific cooperation.

Among the topics of joint investigations, the participants of the meeting discussed issues of cryogenics, development of vacuum systems, automation of cryogenic systems, innovative coatings for inner walls of accelerators and neutron guides, and automation of control systems of engineer infrastructure.

The participants also actively discussed cooperation in training highly qualified engineer staff. They considered the opportunity for students and postgraduates of MSTU to take part in conferences and schools held by JINR, profession discussions of the Institute, as well as theses defense by MSTU students under the scientific guidance of JINR scientists.

The representatives of MSTU had an excursion to VBLHEP, where they saw the factory of superconducting magnets, the NICA collider under construction and its cryogenic compressor station, and vis-

Dubna, 1 March. Representatives of the Bauman MSTU at a meeting with the JINR Directorate

ited the Meshcheryakov Laboratory of Information Technologies.

On 1 March, the JINR–Cuba Meeting on Applied Research and Human Resource Development was held in Havana (Cuba) under the chairmanship of Plenipotentiary of the Government of Cuba to JINR Dr. G. Walwyn Salas. The meeting was attended by the heads of advanced research institutes: the Cuban Centre for Advanced Studies (CEA), Institute of Technologies and Applied Sciences (InSTEC), Centre for Radiation Protection and Hygiene (CPHR), Centre for Technological Applications and Nuclear Development (CEADEN), as well as by young scientists.

Members of the JINR delegation provided general information on the scientific activities of the Institute, as well as spoke about the existing training opportunities for young scientists and students at JINR.

The JINR delegation met with the management, lecturers and researchers of the University of Havana. The meeting was also honoured by the presence of Vice-Minister of Science, Technology and Environ-

Havana (Cuba), 1 March. Participants of the JINR–Cuba Meeting on Applied Research and Human Resource Development

Dubna, 4 March. Visit to JINR by a delegation from Brazil headed by State Secretary for Policy and Strategic Programmes at the Brazilian Ministry of Science, Technology and Innovation Professor M. Barbosa (2nd from left)

ment (CITMA) A. Rodríguez and Vice-President of the Cuban Academy of Sciences C. Rodríguez Castellanos. The possibilities of developing cooperation not only with the University of Havana, but also with the Cuban scientific community as a whole were discussed on the eve of the celebration of the 50th anniversary of Cuba's accession to JINR as a Member State.

On the eve of the meeting, a delegation from JINR, led by Vice-Director L. Kostov, had an opportunity to get acquainted with the infrastructure, scientific topics, and results of CEA. The centre covers a wide range of research in the field of nanotechnology, being focused on the field of biotechnology and medicine.

On 4 March, a delegation from Brazil, headed by Professor M. Barbosa, State Secretary for Policy and Strategic Programmes at the Brazilian Ministry of Science, Technology and Innovation (MCTI), visited JINR.

At the meeting, the sides emphasized the long history of JINR collaboration with Brazil and other Latin American countries, which established a solid foundation for the expansion of cooperation. In his report, JINR Director G. Trubnikov made a review of research priorities and presented the large research infrastructure of JINR.

During the meeting, the sides confirmed the parties' interest in cooperation in basic and applied research according to the Seven Year Plan for the Development of JINR in 2024–2030. It was noted that the BRICS countries have a potential to collaborate multilaterally at the Institute to enhance national science and technology, and train highly skilled personnel.

The delegation got acquainted with the scientific infrastructure of the NICA accelerator complex at VBLHEP and the IBR-2 pulsed reactor with a complex of spectrometers at FLNP, and took part in a round-table meeting.

On 5 March, a working meeting was held in Irkutsk, at which the status of the Baikal-GVD neutrino telescope project was considered. The prospects for increasing the volume of the Baikal-GVD facility and opportunities for expanding the collaboration were discussed. In addition, plans to develop the infrastructure of the Baikal territory and interdisciplinary research on Lake Baikal were announced.

The meeting was organized jointly by JINR, INR RAS, NRNU MEPhI, and Irkutsk State University. The event was attended by representatives of universities involved in the implementation of the Baikal-GVD megascience project: Moscow, Novosibirsk and Kabardino-Balkarian State Universities, and Tomsk Polytechnic University.

One of the key topics of the meeting was the development of the Federal Scientific and Technical Research Programme in the Field of Neutrino Physics and Particle Astrophysics in Russia, which was approved by the RF Ministry of Science and Higher Education in 2023. The construction of the Baikal neutrino telescope with a volume of 1.5–2 km^3 is identified as the most important task of the programme. Also, among the key results of the programme is the deployment of the TAIGA facility over an area of 10 km^2 and development of the Large Baksan Neutrino

Telescope weighing 10 kilotons. JINR and the NRC "Kurchatov Institute" became the leading organizations in the implementation of the programme. The working group for the preparation of priority projects for the neutrino programme included representatives of INR RAS, NRC "Kurchatov Institute", MEPhI, Moscow State University, and JINR.

G. Trubnikov presented to the participants the plans for the further development of the Baikal infrastructure of the Baikal-GVD project, including applied prospects in such areas as electronics, energy, nature-like technologies, medicine, biology, and IT. At the meeting, reports were made by INR RAS staff. Zh.-A. Dzhilkibaev spoke about the Baikal-GVD main scientific results; V. Ainutdinov, about the status of the megafacility; S. Troitsky, about the prospects for high-energy neutrino astronomy and the contribution of the Baikal project to it.

The reports of the representatives of universities discussed the prospects for cooperation and development of interdisciplinary research at Baikal-GVD, the development of software and electronics for optical modules, the investigation of the Baikal-GVD optical module in the NEVOD Cherenkov water detector, the investigation of ultra-high-energy muons for the Baikal-GVD project, the development of the technique of two-phase detectors for registration of low-energy neutrinos, etc.

The participants of the meeting were presented with the project of the All-Russian Ecological Campus EKO.TSEH — a competence centre for eco-tourism and environmentally oriented development that is being established in the city of Baikalsk. The prospects were discussed for joint cooperation in the field of popularization of scientific knowledge in the region.

On 6 March, the participants of the meeting visited the ice camp at the site of the next expedition to deploy the Baikal-GVD deep-sea neutrino telescope.

From 11 to 15 March, a regular International Training Programme for decision-makers in science and international scientific cooperation (JEMS-24) was held at JINR.

Leaders at different levels and staff members as cooperation coordinators from the Francisk Skorina Gomel State University, the Institute of Nuclear Problems of the Belarussian State University, the Patrice Lumumba University of Peoples' Friendship of Russia, the Far East Federal University, the Voronezh, Smolensk and Tver State Universities, and the Institute of Nuclear Physics of the Academy of Sciences of the Republic of Uzbekistan took part in it.

The participants visited all the seven laboratories of the Institute, learned about its top-of-the-line projects, met with leading scientists, listened to lectures on selected areas of the Institute activity, about JINR history, international cooperation, educational programmes and social infrastructure. The JEMS-24 programme also included a visit to the multimedia exhibition "JINR Basic Facilities" and an excursion about Dubna.

At the meeting with JINR Directorate representatives, the participants talked about their plans in

Dubna, 11–15 March. International Training Programme for decision-makers in science and international scientific cooperation (JEMS-24)

the framework of the JEMS programmes and shared their first impressions about their visit to the Institute.

On 15 March, representatives of the Federal Research Centre "Kazan Scientific Centre of the Russian Academy of Sciences" (FRC KazSC RAS) visited the Joint Institute for Nuclear Research: Director of KazSC RAS, RAS Corresponding Member A. Kalachev and Head of the Laboratory of Structural Analysis of Biomacromolecules K. Usachev.

At the meeting, the parties discussed the existing successful examples of bilateral cooperation. In particular, they highlighted joint projects in structural biology. In order to implement the plans, the leaders of JINR and KazSC RAS signed a cooperation agreement. The document involves joint work in the following areas: new imaging methods in radiobiology and medicine (quantum sensors, high-resolution fluorescence microscopy, optoacoustic tomography); structural analysis of biomacromolecules based on small-angle X-ray scattering, synchrotron and neutron radiation methods; research of neurodegeneration mechanisms under the action of ionizing radiation with different physical characteristics; research of the radiosensitizers' action mechanisms for cancer therapy and radioprotective drugs.

At the end of the visit programme, the representatives of the Kazan Scientific Centre of RAS took part in the celebratory seminar dedicated to the 40th anniversary of the launch of the JINR IBR-2 pulsed research reactor.

On 20 March, JINR Director G. Trubnikov and Director of the Alikhanyan National Science Laboratory (AANL, Armenia) G. Karyan signed an agreement on expanding cooperation in the field of fundamental science, information technology, innovation and education. On the same day, the delegates from Armenia visited VBLHEP, where they inspected the NICA accelerator complex: Synchrophasotron hall, MPD pavilion, collider tunnel, and ARIADNA applied research stations.

On 21 March, a JINR–AANL workshop was held at MLIT, during which the members of the Armenian delegation were familiarized with the JINR scientific programme, as well as presented joint ongoing and planned projects.

AANL employees A. Mkrtchyan and G. Mkrtchyan talked about the project of an aerogel detector for the SPD experiment at the NICA collider. Isotope production and measurement of cross sections of nuclear reactions became the subject of R. Dallakyan's report. V. Harutyunyan made a report on the study of the interaction of neutrons and ions with condensed states of matter.

A. Zhemchugov, one of the organizers of the meeting from the JINR side, noted that cooperation between the two large organizations in the field of high-energy physics had been conducted practical-

Dubna, 15 March. Visit to JINR by the representatives of the Federal Research Centre "Kazan Scientific Centre of the Russian Academy of Sciences"

Dubna, 20 March. JINR Director G. Trubnikov and Director of the Alikhanyan National Science Laboratory G. Karyan signed an agreement to expand cooperation in fundamental science, information technology, innovation, and education

ly since the foundation of YerPhI (Yerevan Physics Institute — that was the name of AANL until 2011). Now the AANL group is actively involved in the preparation of the SPD experiment at the NICA complex, in particular, in the creation of an aerogel Cherenkov detector for SPD together with JINR and INP SB RAS.

On 21–22 March, the delegation of the Ministry of Science, Technology, and Environment of the Republic of Cuba (CITMA), headed by Deputy Minister Armando Rodriguez Batista, visited JINR.

During a meeting at the Directorate, the sides noted the long-standing history of cooperation of JINR with the Republic of Cuba. At present, Cuban scientists are actively involved in the implementation of the NICA megascience project as members of an international team.

The Deputy Minister of Science, Technology, and Environment of the Republic of Cuba thanked the JINR Directorate for the opportunity to visit the "Mecca of nuclear sciences". He identified radiobiology, nuclear medicine and life sciences as priority areas for cooperation.

At the meeting, the participants discussed initiatives to hold educational scientific programmes and internships for scientific personnel, as well as to implement programmes for the development of academic mobility of youth engaged in science. The participants discussed training of highly qualified scientific personnel at the Joint Institute.

On the eve of the celebration of the 50th anniversary of Cuba's accession to the Joint Institute as a Member State, the parties discussed the possibility of holding JINR Days in Cuba.

One of the key points of the visit programme was the participation of the delegation in the session of the JINR Committee of Plenipotentiaries. A. Rodriguez Batista presented to the CP members the decision of the Cuban Academy of Sciences to assign the status of Corresponding Member of the Academy to Scientific Leader of the Laboratory of Nuclear Reactions of JINR Yu. Oganessian. The scientist received this title for his outstanding contribution to the global science and as a sign of the Academy's recognition of his merits in educating several generations of Cuban physicists.

During the visit, A. Rodriguez Batista held a meeting with representatives of the national group of the Republic of Cuba at JINR, during which the Cuban scientists spoke about their scientific work and life in Dubna.

On 22 March, Vice-Minister of Science and Higher Education of the Republic of Kazakhstan D. Ahmed-Zaki visited JINR. At a meeting at the JINR Directorate, the parties discussed the implementation of several scheduled joint projects in the areas of nuclear medicine and the development of a large facility with an ultracold neutron channel. An advanced research project with ultracold neutrons has already succeeded to attract the attention of not only Dubna and Kazakhstan scientists, but also specialists from many other countries.

As an example of successful cooperation experience, the parties noted the DC-60 accelerator complex created in Kazakhstan with the Institute's help. For many years, JINR has continued to supervise the project, helping Kazakhstani specialists keep up its status as one of the best accelerators in Europe.

Dubna, 29 March. Signing of an agreement between JINR and the Higher School of Economics by JINR Director G. Trubnikov and HSE Rector N. Anisimov

Another example of effective cooperation was the launch of a cloud computing cluster at the Institute of Nuclear Physics in Almaty in 2023. Thanks to this, the Republic's scientists have access to the powerful resources of the JINR computing infrastructure.

During the meeting, special attention was paid to the discussion of joint programmes for training highly qualified scientific staff on the basis of JINR. D. Ahmed-Zaki participated in the session of the JINR Committee of Plenipotentiaries.

In addition, the distinguished guest got acquainted with the flagship projects of the JINR scientific infrastructure, including the NICA megascience project at the Veksler and Baldin Laboratory of High Energy Physics, the IBR-2 pulsed reactor at the Frank Laboratory of Neutron Physics, the Superheavy Element Factory at the Flerov Laboratory of Nuclear Reactions, and the Govorun supercomputer at the Meshcheryakov Laboratory of Information Technologies.

At the end of the visit programme, the Vice-Minister held a meeting with the national group of the Republic of Kazakhstan at JINR, where Head of the group Ye. Mukhamejanov made a report on scientists' activities.

On 28 March, representatives of the Hefei Institutes of Physical Science (HFIPS) and the Institute of Plasma Physics of the Chinese Academy of Sciences (ASIPP) visited JINR. The delegation discussed with the JINR Directorate the issues of scientific cooperation and joint participation in international projects. JINR Director G. Trubnikov spoke about the successful track record of cooperation in international experiments between the Institute's scientists and their colleagues from China, highlighting the importance of establishing partnerships between JINR and large research centres and laboratories in China.

As part of the visit programme, the representatives of JINR management and their Chinese colleagues held a meeting regarding the issues related, in particular, to the organization of a BRICS Workshop on research infrastructure in Dubna.

At VBLHEP, the delegation members got acquainted with the progress of the NICA megascience project and visited the experimental hall of the MPD detector and the superconducting magnet factory.

On 29 March, the Joint Institute for Nuclear Research and the Higher School of Economics signed an agreement at JINR. The signatories of the document were JINR Director G. Trubnikov and HSE Rector N. Anisimov. The agreement outlines the key areas of cooperation between the organizations, including joint participation in the major experiments of the NICA megascience project, partnership in the field of theoretical physics, information technology, and personnel training.

At the meeting at the JINR Directorate, the sides discussed the key areas that are promising for joint research. It was noted that the HSE and BLTP JINR have a long history of cooperation in mathematical physics. HSE physicists and mathematicians are already contributing to the implementation of the MPD and BM@N projects at the NICA complex. The parties discussed the possibility of holding lectures and seminars together, as well as organizing R&D Days at JINR for an indepth presentation of the JINR and HSE potential in research and development work.

During the visit to JINR, the leaders of the Higher School of Economics visited the technical sites of the Institute to get acquainted with the MPD pavilion and the superconducting magnet factory at VBLHEP, and the Govorun supercomputer at the Meshcheryakov Laboratory of Information Technologies.

On 1–5 April, JINR hosted a scientific session of the RAS Nuclear Physics Section of the Department of Physical Sciences, dedicated to the 300th anniversary of the Russian Academy of Sciences. The programme of the event covered the main theoretical and experimental aspects of particle physics and related problems of nuclear physics and cosmology.

Opening the session, JINR Scientific Leader Academician V. Matveev spoke about the beginning of the implementation of a new Seven-Year Plan for the Development of JINR, emphasizing the importance of strengthening international scientific cooperation. JINR Director Academician G. Trubnikov addressed the guests of the event with a welcoming speech. BLTP Director D. Kazakov spoke about the format, programme and organizational issues of the scientific session.

The scientific programme of the event was opened by a report by G. Trubnikov on the topic "NICA Accelerator Complex: Challenges and Solutions", which presented the status of the implementation of the NICA megascience project, the preparedness for commissioning of the main elements and experimental facilities of the accelerator complex, and characterized the main scientific objectives of the project.

During the plenary session of the first day, Head of the MPD collaboration V. Ryabov made a report on the physics of collisions of heavy nuclei, and FLNR Scientific Leader Academician Yu. Oganessian made a presentation devoted to superheavy nuclei and elements.

During the scientific session, more than 200 reports were presented on the topics stated in the programme: physics on proton–proton and e^+e^- colliders; physics of relativistic heavy ions; quantum field theory; gravity and cosmology; physics of aromas (CKM, CP, g – 2...); neutrino physics; astrophysics of particles and cosmic rays; dark matter; exotics (axions...); nuclear physics of low and intermediate energies; structure and spectroscopy of hadrons (including *XYZ*, glueballs...); detectors, experimental methods; physics and technology of accelerators; fundamental nuclear physics.

On 8 April, O. Rebkovets, Acting Rector of the Vitus Bering Kamchatka State University (KamSU), paid a visit to JINR. During the meeting with JINR Director G. Trubnikov, issues of scientific cooperation and the implementation of new joint educational programmes were discussed.

The KamSU Rector honored the successful experience of the JINR Information Centre in organizing scientific schools and other educational events against the backdrop of the rising number of students choosing physics and mathematics majors observed in the region.

Director of the JINR UC D. Kamanin, who was also present at the meeting, emphasized the high efficiency of the JINR InfoCentre at KamSU and spoke about further plans for interaction between the UC and the InfoCentre. Reciprocally, Head of the JINR IC at KamSU D. Israpilov announced plans to develop contacts with JINR partners through the IC.

As part of the visit, the Rector of KamSU visited scientific facilities in the laboratories of the Institute and got acquainted with an engineering workshop at the UC.

On 14 April, an agreement between JINR and the National Academy of Sciences of the Republic of Armenia on cooperation in the fields of fundamental science, information technologies, innovation, and education was signed in the JINR Directorate. Ac-

Dubna, 14 April. Signing of an agreement between JINR and the National Academy of Sciences of the Republic of Armenia on cooperation in the fields of fundamental science, information technologies, innovation, and education

cording to the document, the JINR–NAS RA Scientific and Technological Centre will be established in the Academy of Sciences of Armenia. It will aim to maintain contact of scientists and specialists of the Republic's research institutes with JINR, deepening partnerships in the scientific and technical field, in personnel training, and in popularization of life sciences. The document was signed by JINR Director Academician G. Trubnikov and President of the National Academy of Sciences of the Republic of Armenia A. Saghyan. The parties agreed to appoint those responsible from Armenia for joint work.

During the visit, the guests got acquainted with the scientific infrastructure of the Superheavy Element Factory at FLNR.

From 17 to 19 April, JINR employees visited Kazan (Volga Region) Federal University and the Federal Research Centre "Kazan Scientific Centre of the Russian Academy of Sciences". JINR scientists organized a seminar at the KFU Institute of Physics for 3rd–4th year students studying physics, radiophysics, nanotechnology, and astronomy.

At the seminar, aimed at attracting applicants to the JINR-based Department of Nuclear Materials Science (Department Head: Corresponding Member of the Russian Academy of Sciences A. Belushkin), FLNP Senior Researcher at the Scientific and Experimental Department of Neutron Investigations of Condensed Matter Yu. Gorshkova told students about scientific activities and educational programmes at JINR. LRB Director A. Bugay made a review report "Radiobiological research at JINR accelerators". A report by MLIT Scientific Leader V. Korenkov "Methods and technologies of data processing in heterogeneous computing environments" initiated a lively discussion.

As part of the visit, the JINR employees visited scientific laboratories of the Arbuzov Institute of Organic and Physical Chemistry and Kazan Zavoisky Physical and Technical Institute. At the meetings with IP KFU Director M. Gafurov and FRC KazSC RAS Director A. Kalachev, the parties confirmed their intentions to strengthen scientific ties as part of signed bilateral agreements.

On 19 April, the Cuban Isotope Centre (CENTIS) Deputy Directors R. A. Serra Aguila and J. C. Cruz Arencibia visited JINR. CENTIS is a leading Cuban enterprise for the production and development of radiopharmaceuticals.

During the meeting with JINR Deputy Chief Scientific Secretary A. Zhemchugov, the delegation discussed issues of developing cooperation in nuclear medicine, medical engineering, radiochemistry, and personnel training. Also, the parties expressed interest in preparing a trilateral cooperation agreement between CENTIS, the University of Havana, and JINR on the implementation of educational programmes and personnel training.

During the business trip, the delegation visited FLNR, where the guests were presented the projects of JINR scientists in the field of proton therapy and microtomography, and also got acquainted with the research and experimental equipment of LRB.

On 22 April, a webinar was held, organized by the Arab Atomic Energy Agency (AAEA) in cooperation with JINR and the Women in Nuclear Tunisia, and dedicated to research in life sciences and applied environmental developments. The webinar was attended by representatives of Tunisia, Libya, Egypt, Yemen, Syria, Iraq, Jordan and other countries: about 60 participants in Zoom and about 400 in social networks.

The participants of the webinar, which was a continuation of a series of joint events between JINR and AAEA, were welcomed by Special Representative of the JINR Director for Cooperation with International and Russian Scientific Organizations B. Sharkov. He spoke about the experience of the Joint Institute's cooperation with the AAEA and also informed about the planned participation of JINR in the IAEA Lise Meitner Programme aimed at developing the careers of women in the nuclear field.

As part of the online event, FLNR researcher U. Pinaeva presented a report on radiation-induced modification of polymers. The founder and President of Women in Nuclear Tunisia A. Zaouak (Tunisia) thanked the AAEA and JINR for expanding international cooperation between scientists and promoting the idea of peaceful use of nuclear technologies for the benefit of science.

On 23–25 April, the 13th Collaboration Meeting of the MPD Experiment at the NICA Facility was hosted by VBLHEP.

Opening the meeting, JINR Vice-Director V. Kekelidze noted the robust progress and expansion of the MPD collaboration, which currently includes scientific groups from 38 centres around the world.

The Chief Engineer of the NICA accelerator complex, E. Syresin, made a report on the current situation and running preparations for the launch of the complex. He spoke about the successful testing of key structural elements of the complex: cyclic superconducting accelerators — the Nuclotron and the Booster, the electronic cooling systems, the power supply systems, as well as the main elements of the injection complex. In the collider tunnel, stations of high-frequency systems HF-1 and HF-2 were installed and tested for operability. According to the speaker, the first technological launch of the main systems of the NICA accelerator complex is planned for December 2024, and the launch of the first ion beam should take place in the spring of 2025.

The Head of the MPD collaboration, V. Ryabov, presented the collaboration work schedule for 2024–2025.

The Head of the MPD Scientific and Experimental Department, V. Golovatyuk, covered in his talk the progress of work on creation of structural elements of the multipurpose detector, presenting their functional features and characteristics.

Dubna, 26 April. Dubna school teachers — winners of 2023 JINR Grant Competition, awarded at the meeting of the JINR Science and Technology Council

During the meeting, over 30 collaboration participants presented their reports on the areas of current research in the field of heavy ion physics. As part of the meeting agenda, the participants took a tour of the experimental hall of the MPD detector.

On 26 April, at the JINR International Conference Hall, a meeting of the JINR Science and Technology Council was held, chaired by E. Kolganova. The participants heard a report by JINR Director G. Trubnikov on the latest results of JINR activities: the status of work on the NICA project, the results of the regular annual Baikal expedition, the state of affairs with the IBR-2 reactor, progress in the development of the Institute's information and computing resources, work on the creation of the MSC-230 medical cyclotron, as well as the construction of a new building for the U-400R accelerator, on activities to improve social infrastructure, and recent developments in the field of international cooperation.

The report of JINR Vice-Director L. Kostov was dedicated to the new rules for organizing international scientific and technical cooperation at the Joint Institute. A draft regulation was developed that specifies the functions and responsibilities of coordinators and persons responsible for interaction with JINR Member States and partners, as well as with international organizations. The regulations were presented for discussion with members of the Science and Technology Council.

Head of the JINR International Cooperation Department O.-A. Culicov provided statistics on the Institute's employees from Member States and partner countries, and also put forward a proposal on measures and mechanisms to support employees that have no national groups in Dubna.

The JINR Science and Technology Council unanimously supported the nomination of JINR Scientific Leader Academician V. Matveev for the N. N. Bogoliubov Gold Medal of the Russian Academy of Sciences.

The JINR Director awarded JINR grants to 12 teachers from Dubna schools. The employees of the Joint Institute were awarded departmental awards from the Ministry of Science and Higher Education of the Russian Federation and from the Rosatom State Corporation.

On 27 April, a working meeting on cooperation between the Rosatom State Corporation and JINR was held in Dubna, chaired by General Director of the state corporation A. Likhachev and JINR Director Academician G. Trubnikov.

The main programme of the meeting included reports on the development of joint projects and research presented by JINR scientists and representatives of Rosatom.

JINR Vice-Director S. Dmitriev made a presentation about the work at the JINR Superheavy Element Factory, introducing the results and plans for the development, including the synthesis of elements 119 and 120.

JINR Director G. Trubnikov announced plans for the development of the JINR scientific infrastructure for 2024–2030 in the key areas of scientific research of the Institute and prospects for cooperation between JINR and Rosatom. Ideas for new projects with prospective participation of the state corporation were put forward.

The parties also outlined the main areas of interaction between JINR and the Rosatom State Corporation on the IBR-2 nuclear research facility project and the creation of a new pulsed neutron source.

As part of the meeting programme, a ceremony was held to present Badges of Honor of the Rosatom State Corporation to JINR employees for significant achievements in their research activities and great personal contribution to the development of nuclear industry.

At the end of the meeting, the participants reached a decision to jointly prepare a new cooperation agreement between JINR and the Rosatom State Corporation.

Dubna, 27 April. A working meeting on cooperation between JINR and the Rosatom State Atomic Energy Corporation

At the end of April, the 2nd JINR–AANL workshop took place at the A. Alikhanyan National Science Laboratory (AANL, YerPhI), Armenia.

The meeting gave space for a detailed discussion of issues of cooperation between JINR and Armenian scientific centres in the field of fundamental science, information technology, innovation and education, but it was also supposed to identify specific thematic areas of activity of the laboratory being created.

During the plenary sessions, which covered a wide range of topics from information technology to nuclear physics and materials science, the heads of Armenian research organizations presented the scientific programme of their institutes, paying particular attention to the ongoing and planned joint work with JINR.

An important outcome of the workshop was the signing of an agreement for AANL (YerPhI) to join the ARIADNA collaboration on applied research at the NICA complex.

As a result of many years of cooperation of AANL (YerPhI) with FLNP JINR, an additional agreement was signed in the field of scientific and methodological research and development for studying condensed matter on IBR-2 neutron beams and functional materials and nanosystems using neutron scattering.

The meeting was finalized with a decision to support further development of the initiative to create a joint JINR–AANL laboratory and encourage the working groups to submit their proposals, including information on the tentative staffing of the JINR–AANL laboratory, the necessary financial resources, equipment and provision of appropriate premises for carrying out scientific research and development activities.

On 13–17 May, the 12th Collaboration Meeting of the BM@N Experiment was held in a mixed format in Almaty at the Satbayev Kazakh National Research Technical University (KazNRTU).

The meeting was opened by Vice-Rector for International Cooperation and Strategic Development of KazNRTU S. Yermekbayev. He welcomed the participants and thanked JINR for organizing the event.

The meeting was devoted to the reconstruction and identification of strange particles, as well as to the analysis of topology of events in collisions of xenon (Xe) beam nuclei with a cesium iodide (CsI) target, obtained during a physical session at the Booster–Nuclotron complex. The participants looked into the status of physics analysis and preparation of publications on previously reported argon-nuclear interaction data, and discussed the physics programme and detector configuration in the next session at the BM@N facility.

As part of the plenary session agenda, M. Kapishin, the collaboration supervisor and Head of the Scientific and Experimental Department of Baryonic Matter at VBLHEP JINR, gave a report on the results and status of the BM@N project. The speaker also announced plans to upgrade the facility for future physical runs of the BM@N experiment.

S. Piyadin, Deputy Head of the Multi-Purpose Detector Department, spoke about the development of the BM@N facility configuration and operation of the detectors during a physical run on a beam of xenon nuclei. V. Lebedev, Deputy Head of the Accelerator Department for Scientific Work at VBLHEP JINR, reported on the status of the superconducting accelerators of the NICA complex — the Booster and the Nuclotron — as per the planned modernization of the collider injector complex. Overall, more than

Almaty (Kazakhstan), 13–17 May. Participants of the 12th Collaboration Meeting of the BM@N Experiment

50 reports on the implementation of the BM@N project were presented at the meeting.

On 17 May, the final day of the meeting, KazNRTU hosted the annual international seminar "NICA Days 2024", where participants were familiarized with the megascience project status, as well as the physical programme of experimental installations of the NICA accelerator complex: BM@N, MPD, SPD, and ARIADNA. The event was also organized with a view to addressing students, postgraduate students, and young scientists in order to encourage their participation in the project.

On 14–17 May, Nizhni Novgorod was hosting the 10th meeting of the Scientific Council of the RAS Physical Sciences Department on Heavy Ion Physics "Relativistic Nuclear Physics and Heavy Ion Physics", organized by JINR and the RAS Institute of Applied Physics. The meeting was attended by representatives of RFNC VNIIEF (Sarov), SSC RIAR (Dimitrovgrad), FSUE EHP (Lesnoy), NIIEFA (St. Petersburg), NCPM (Sarov), and SPbSU (St. Petersburg).

Academician Yu. Oganessian, Chairman of the Council, FLNR Scientific Leader, opened the session. IAP RAS Director Academician G. Denisov and JINR Scientific Leader Academician V. Matveev addressed the guests with welcoming words.

JINR Director Academician G. Trubnikov made a report on the JINR physics programme, its key goals and objectives. He also focused on the main historical milestones in the development of nuclear physics at the Joint Institute and outlined the prospects for research in heavy ion physics.

Nizhni Novgorod, 14–17 May. The 10th meeting of the Scientific Council of the RAS Physical Sciences Department on Heavy Ion Physics "Relativistic Nuclear Physics and Heavy Ion Physics"

São Paulo (Brazil), 29 May. JINR delegation at the Nuclear and Energy Research Institute (IPEN) of CNEN

Yu. Oganessian introduced the programme of the meeting and made an overview report on the Superheavy Element Factory, describing the goals, results, and plans for research in the field of heavy ion physics. In his report, the scientist paid special attention to the national project "Atom and New Energy Technologies", implemented by a consortium of institutes of the Rosatom State Corporation and JINR.

During the meeting, more than 30 scientific reports on low- and high-energy heavy-ion physics and applied research were presented.

At the session, the ceremony of awarding the international Flerov Prize for outstanding work in the field of nuclear physics and nuclear chemistry took place.

In the second half of May, a JINR delegation was on an official visit to Brazil. On 19–23 May, the JINR representatives took part in the Autumn Meeting of the Brazilian Physical Society (SBF) in Florianopolis and in a seminar of the Faculty of Physics of the Federal University of Santa Catarina. On 27–29 May, the delegation visited the institutes of the National Nuclear Energy Commission (CNEN).

The Autumn Meeting is the largest condensed matter meeting in the country, bringing together about a thousand participants from Brazilian research organizations and universities.

Professor N. Kučerka, Deputy Head of the JINR Department of Science Organization Activities, presented the activities of JINR and the overall opportunities for cooperation at the special session "Collaboration opportunities at the Joint Institute for Nuclear Research". Professor Kh. Kholmurodov, FLNP JINR employee, presented an example of the Institute's scientific results in the report "Performing molecular dynamics studies of nanosized systems combined with neutron scattering experiments".

After the meeting of the Physical Society, the possibilities of cooperation at JINR were discussed at a seminar of the Faculty of Physics of the Federal University of Santa Catarina, during which special attention was paid to the opportunities for academic exchange.

On 27 May, the JINR representatives visited the Nuclear Technology Development Centre (CDTN) of the CNEN located at Belo Horizonte. The local facilities included in the programme of the scientific visit were the Radiopharmacy Centre, Applied Physics Laboratory, and TRIGA research reactor.

On 28 May, the JINR delegation visited the Nuclear Engineering Institute (IEN) of the CNEN located in Rio de Janeiro. An excursion to the Argonauta research reactor and visits to the related laboratories were organized for JINR representatives. The Brazilian colleagues presented their graduate programmes on nuclear science and technology, and radioprotection and dosimetry, and Deputy Director of FLNP S. Kulikov spoke about educational programmes of JINR.

On 29 May, the delegation visited the Nuclear and Energy Research Institute (IPEN) of the CNEN at São Paulo. Presentations on the structure and activities of IPEN, JINR, and Northeast Regional Centre of Nuclear Sciences (CRCN-NE), as well as on the programmes of the institutes for graduates and advanced training, were made. Visits to the IEA-R1 research reactor and cyclotron accelerators took place.

As a result of the meetings and technical visits, a wide range of topics of mutual interest were identified.

On 20–24 May, the Kazakh–British Technical University (Almaty) hosted the 7th Collaboration Meeting of the SPD Experiment at the NICA Accelerator Complex.

Opening the meeting, A. Guskov, co-leader of the collaboration and Deputy Director of DLNP JINR, expressed his gratitude to the Kazakh–British Technical University (KBTU) and the Institute of Nuclear Physics of the Ministry of Energy of the Republic of Kazakhstan for their assistance in organizing the event.

KBTU Rector M. Gabdullin and Deputy General Director for Scientific Work of the Institute of Nuclear Physics of the Ministry of Energy of the Republic of Kazakhstan N. Saduev addressed the meeting participants with a welcoming speech.

V. Kim, co-leader of the collaboration and Deputy Head of the Department of High Energy Physics at the Konstantinov Petersburg Nuclear Physics Institute (NRC "Kurchatov Institute"), gave a talk on the status and development of the SPD project. Currently, the SPD collaboration brings together more than 400 representatives from 15 countries and continues to expand. Following the presentation, a preliminary work plan for the SPD project was presented.

Deputy Chairman of the SPD Collaboration Council A. Tumasyan (Alikhanyan National Science Laboratory) indicated in his report the positive growth of the number of organizations ready to participate in the project. The Chair of the SPD Collaboration Council, Professor E. Tomasi-Gustafsson (CEA Saclay, France), addressed the participants with words of gratitude for the fruitful work on the experiment.

During the meeting, the designated coordinators reported on the technical and physical components of the experiment, as well as on the development of software and IT infrastructure. The participants discussed in detail the status of work on the main subsystems of the installation, electronics and software of the experiment. Careful consideration was given to the SPD physics programme.

From 20 May to 18 June, the 17th annual International Internship for Young Scientists and Specialists from CIS countries was held at JINR. Young scientists, specialists, and students from Armenia, Azerbaijan, Belarus, Kazakhstan, Russia, Tajikistan, and Uzbekistan, representing leading scientific and educational centres of their countries, took part in the internship.

During the internship, the participants got acquainted with the JINR research infrastructure, the topics of scientific research in the laboratories of the Institute, visited enterprises of the Special Economic Zone, and the Dubna State University. Young scientists worked in international teams of 4–5 people to prepare scientific, technological or innovative projects. The experience has shown that young scientists keep in touch in the future, jointly participating in conferences and preparing publications together.

As a result of the internship, projects were defended, the authors of the best of which will have

Almaty (Kazakhstan), 20−24 May. The 7th Collaboration Meeting of the SPD Experiment at the NICA Accelerator Complex

Dubna, 20 May – 18 June. The 17th International Internship for Young Scientists and Specialists from CIS countries

the opportunity to participate in the ININC CIS annual grant competition with the support of the Intergovernmental Foundation for Educational, Scientific, and Cultural Cooperation of the CIS countries and JINR.

On 31 May, the VBLHEP conference hall opened its doors to the ARIADNA Collaboration Meeting, which was dedicated to scientific programmes of the seven organizations that received support from the Ministry of Science and Higher Education of the Russian Federation to carry out applied research using the infrastructure of the NICA complex.

Opening remarks and welcome addresses were given by JINR Vice-Director L. Kostov. The Head of the ARIADNA collaboration, O. Belov, briefed the audience about the status of the ARIADNA collaboration, its members and current tasks, and wished the colleagues successful and fruitful work.

The workshop agenda included reports on radiation materials science and radiation modification of materials, biomedical research and testing of radiation resistance of electronics using ion beams from the NICA accelerator complex.

The meeting was held in a hybrid format and brought together more than 100 participants from JINR, NRNU MEPhI, MIPT, Federal Research Centre of Chemical Physics of RAS, Institute of General Inorganic Chemistry of RAS, Institute of Medical and Biological Problems of RAS, Institute of Theoretical and Experimental Biophysics of RAS, and North Ossetian State University.

Currently, the collaboration comprises 162 representatives from 21 organizations from five countries. The ARIADNA research programme has been launched; at the end of 2022 – beginning of 2023, an experiment was carried out on extracted beams of high-energy ions, and the first results were obtained.

The main module of talks included presentations of scientists from organizations participating in the collaboration, who presented their work plans in their spheres of interest. On the whole, 28 reports were devoted to the ARIADNA scientific programme.

The meeting wrapped with a discussion of its results and plans for the near future. It was decided to prepare the first scientific article on behalf of the collaboration for publication in one of the international journals.

On 13 June, during the visit to Dubna, President of the Russian Federation V. Putin initiated the technological launch of a megascience facility — the superconducting collider of the NICA accelerator complex.

This crucial stage in the implementation of the NICA megascience project marks the beginning of preparations for the physics run of the complex. Since this moment, testing is underway of the power supplies of the collider's superconducting magnets and the superconducting magnet of the MPD (Multi-Purpose Detector), the first experimental facility of the complex.

V. Putin, accompanied by JINR Director Academician G. Trubnikov, visited the NICA accelerator complex and got acquainted with the technological features of the assembly of the heavy-ion collider ring of NICA. After visiting the MPD experimental facility, the President of the Russian Federation gave the

The Veksler and Baldin Laboratory of High Energy Physics, 31 May. Participants of the ARIADNA Collaboration Meeting

command to supply a test current to the magnetic system of the NICA complex, initiating the technological launch of the collider.

At the MPD experimental hall, V. Putin held a meeting with leading Russian and foreign scientists and winners of megagrants for scientific research. "We are open to working together and benefiting from the progress made through your work, and welcome the use of its results not only in Russia, but also in other countries," the President of the Russian Federation highlighted.

The NICA heavy ion collider is one of the flagship megascience projects being implemented in Russia. Scientists from 30 countries of the world, as well as the European Organization for Nuclear Research (CERN), are involved in the creation of the complex. The NICA project unites more than 130 scientific institutes, universities, and enterprises, 36 of which represent the Russian Federation. The collaboration includes 2400 specialists, with 1650 of them being Russian.

On 13 June, President of the Russian Federation V. Putin held a meeting of the Council for Science and Education at the JINR International Confrence Hall. The main issue on the agenda was the formation and implementation of national projects supporting technological sovereignty.

The meeting was attended by the Deputy Chairman of the Security Council of the Russian Federation, D. Medvedev; the First Deputy Chairman of the Government of the Russian Federation, D. Manturov; the Assistant to the President of the Russian Federation, A. Fursenko; the Chairman of the Federation Council Committee on Science, Education, and Culture, L. Gumerova; the Minister of Science and Higher Education of the Russian Federation, V. Falkov; the Rector of Moscow State University, V. Sadovnichy; the Director General of Rosatom State Corporation, A. Likhachev; the Director General of the Russian Science Foundation, V. Bespalov, and other members of the Council.

Welcoming the participants of the meeting, V. Putin noted the symbolism of the fact that the meeting of the Council discussing Russia's scientific and technological priorities was taking place in Dubna, as well as congratulated the members of the Council, the Russian and international scientific community, and all JINR employees on the landmark event, the initiation of the technological launch of the NICA facility.

Deputy Prime Minister of the Russian Federation D. Chernyshenko announced the priorities of scientific and technological development of the Russian Federation and spoke about the upcoming project of national technological sovereignty, which will include federal projects dedicated to science and technology. He also drew the Council's attention to the need for appropriate staffing of national projects. A detailed expertise of all projects will be conducted by the Russian Academy of Sciences.

RAS President G. Krasnikov presented to the Council members the priorities of scientific and technological development for the Russian Federation, which were formulated by the RAS in collaboration with a wide range of scientists and experts.

JINR Director Academician G. Trubnikov expressed support for the list of the most important high-tech technologies prepared by the Government and the Russian Academy of Sciences on behalf of the President of Russia.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ОБЪЕДИНЕННЫЙ ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ

Dubna, 13 June. RF President V. Putin visited the NICA accelerator complex and held a visiting meeting of the Council for Science and Education

The President of the Russian Federation concluded the event by announcing that a decree will be signed in the near future to approve priority areas for scientific development in Russia.

On 14 June, the International Conference Hall of JINR hosted the conference "Science Cities of Russia: Current Objectives", dedicated to the Day of Science Cities of the Moscow Region. Representatives of 13 Russian science cities participated in the event. The conference was moderated by JINR Director G. Trubnikov.

Opening the event, Head of the Dubna city district M. Tikhomirov congratulated all the representatives of science cities present and thanked the Joint Institute for their help in organizing the event.

During the meeting, G. Trubnikov presented a project of the International Innovation Park of Science and Technology, which is planned to be built in Dubna. The project implies the comprehensive development of adjacent territories and will be implemented jointly by JINR, Dubna SEZ, Dubna State University, as well as local governments, regional and federal executive authorities. A list of majors and educational programmes that the city's enterprises need today was presented. The most popular areas were "Artificial intelligence and big data", "Nuclear physics methods and life sciences", and "Engineering sciences and materials science".

In the second part of the plenary session, a speech was delivered by Director of the Union for the Development of Science Cities M. Kuznetsov. Reports on the development of science cities were presented by the heads of the urban districts of Fryazino, Chernogolovka, Koltsovo, and Obninsk. At the conference, a ceremony took place to award researchers from science cities of the Moscow Region for their outstanding achievements in science.

On 14 June, JINR hosted the 1st JINR–NRU HSE workshop within the framework of an agreement signed in March 2024, which defines the main areas of cooperation, including participation in experiments of the NICA megascience project, interaction in the field of theoretical and mathematical physics, information technologies and training.

JINR Chief Scientific Secretary S. Nedelko spoke briefly about JINR, stressing that the Institute is one of the leaders among international intergovernmental scientific organizations in terms of scale, range and effectiveness of research, and number of staff. He also noted that JINR and HSE, due to the multidisciplinary nature and organization of their work, have a high potential for developing cooperation.

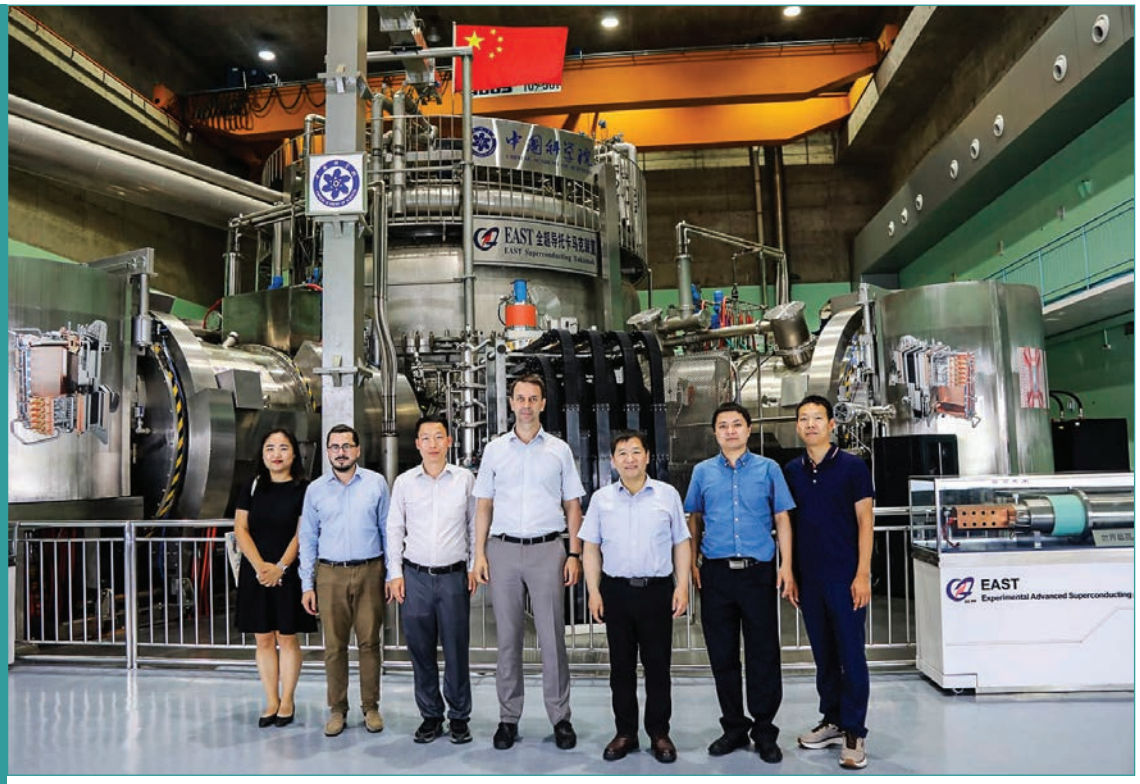
The NRU HSE Senior Director for Research and Development, A. Sudarikov, presented the structure and activities of this interdisciplinary research centre.

The plenary session of the workshop was opened by VBLHEP Acting Director A. Butenko. Greeting the participants of the meeting, he reported on the status of the implementation of the NICA megascience project.

During the parallel sections, the workshop held substantive discussions of the scientific programme of the experimental collaborations MPD, SPD, and BM@N at NICA, mathematical methods in life sciences, some aspects of modern mathematics and mathematical physics, the development of information technologies for storing and processing data from physical experiments. The participants discussed the possibilities of training highly qualified scientific personnel, including conducting student practice and internships at JINR.

On 1–2 July, JINR's delegation headed by G. Trubnikov visited the Institute of Plasma Physics of the

Dubna, 14 June. The conference "Science Cities of Russia: Current Objectives"



Hefei (China), 1–2 July. Visit of JINR delegation to the Institute of Plasma Physics of the Chinese Academy of Sciences (ASIPP)

Chinese Academy of Sciences (ASIPP) in Hefei (China). During the visit, a resourceful meeting was held with ASIPP Director Professor Song Yuntao, where prospects of expanding scientific cooperation between the two scientific centres were discussed.

JINR and the Institute of Plasma Physics of CAS have been actively working together since 2010, demonstrating remarkable scientific results in accelerator technology, low-temperature and superconductivity physics, medicine physics in proton radiation therapy. In particular, as part of the NICA project, several unique superconducting magnetic devices were developed in cooperation, including with the use of high-temperature superconductiv-

Dubna, 2–3 July. Participants of the 6th meeting of the BRICS Working Group on Research Infrastructures and Megascience Projects

ity. In addition, superconducting proton cyclotrons (C200 and C240) for the Proton Therapy Centre in Hefei were designed and built jointly.

In his welcoming speech, ASIPP Director Song Yuntao stressed the importance of joint international work to achieve significant scientific results and expressed confidence in enhancing fruitful cooperation with JINR. The parties held a detailed working meeting, discussed the results of current research, and identified key areas of future joint projects. The topics discussed included promising developments in high-temperature superconductivity, the creation of compact medical cyclotrons and diagnostic systems, nuclear physics methods for environmental and climate research, as well as academic exchanges.

During the visit, the JINR delegation was introduced to the ASIPP research infrastructure and its contribution to the scientific development of the People's Republic of China. In appreciation of the long-term and trustful partnership with JINR, G. Trubnikov was honoured to plant a tree in the International Friendship Park on Science Island, the tea olive (*Osmanthus fragrans*), the symbol tree of Hefei.

From 1 to 5 July, Irkutsk State University (ISU) hosted the 2nd Coordination Workshop on Swift and Multicharged Heavy Ions in Radiation Materials Science. JINR employees and representatives of Kazakhstan, Russia, Serbia, and South Africa took part in the event. The meeting aimed at discussing the status and prospects for the development of joint research.

The event participants considered proposals relating to work areas focusing on new methodological possibilities for studying radiation-stimulated changes in the properties of materials. The research is planned to be carried out on the DC-140 cyclotron being created at the JINR Laboratory of Nuclear Reactions, the homogeneous ion implantation facility at the Tandetron accelerator at iThemba LABS, irradiation facilities at the DC-60 cyclotron (Astana), and the FAMA Complex (Belgrade).

The project of a cyclotron complex for simultaneous target irradiation with beams of hydrogen, helium, and one of the metal ions (iron, chromium, nickel) was considered as a promising area for the development of a methodological basis for joint research in radiation materials science. It is the most effective method for testing new reactor materials.

As part of the 2024 Russia's BRICS Chairmanship, the 6th meeting of the BRICS Working Group on Research Infrastructures and Megascience Projects was held on 1 July in Moscow at the NRC "Kurchatov Institute" and continued **on 2 and 3 July** in Dubna, at the International Conference Hall of the JINR with all BRICS states, including new member states of this organization.

Vice-Director of the Joint Institute L. Kostov opened the meeting in Dubna. Speaking on behalf of the JINR Directorate, he expressed the Institute's readiness to actively promote the expansion of par-

ticipation of the BRICS countries in JINR activities, both in the development of the large research infrastructure and in conducting scientific research with its application.

During the meeting, the participants talked about the scientific and technological policies and strategies of the BRICS member states in terms of research infrastructure. The meeting participants visited a number of large JINR facilities, such as the NICA accelerator complex, the Superheavy Element Factory, and the IBR-2 reactor with a spectrometer complex.

On 3 July, the 2nd meeting of the JINR–China Joint Coordination Committee on Cooperation was held in Shanghai, co-chaired by Director of the Joint Institute for Nuclear Research Academician G. Trubnikov and Vice-Minister of Science and Technology of China Long Teng, in the framework of the quadripartite protocol between the Ministry of Science and Higher Education of Russia, the Ministry of Science and Technology of China, the Joint Institute for Nuclear Research, and the Chinese Academy of Sciences (CAS) on strengthening cooperation in the field of basic scientific research, signed in March 2023.

The meeting participants heard a report on the activities of the Expert Working Group under the Committee and its recommendations on research projects that are of interest for both sides. According to the decision of the Committee, eight projects that received the most support from experts are to be launched in 2024. The projects cover a wide variety of physics branches: theoretical physics, the development of technologies for the deep underwater cubic-kilometre neutrino telescope, the use of neutron beams to solve fundamental and applied problems, the synthesis and study of the properties of superheavy elements, the development of accelerator technologies, the creation of monolithic silicon detectors, and cooperation as part of the JUNO neutrino experiment under construction in China. In addition, the Expert Working Group proposed supporting a joint academic exchange programme and scientific events programme. The following leading scientific institutions and universities of the country are among the main organizations responsible for the implementation of the projects on the part of China: Institute of High Energy Physics of CAS (IHEP, Beijing), CAS Institute of Modern Physics (Lanzhou), Central China Normal University (Wuhan), CAS Institute of Theoretical Physics (Beijing), and a number of other research centres.

The sides expressed interest in expanding the list of cooperation areas, particularly in information technology. Both JINR and IHEP are using the DIRAC Interware Platform to build distributed multilevel heterogeneous computing systems, which allows processing data from megascience projects, such as NICA at JINR and JUNO and BESIII at IHEP. In addition, there could be significant potential for cooperation in the field of radiobiology and medicine between JINR and PRC. Considering China's significant achievements in life sciences, particularly in radiation biology, and the advanced use of the latest

Shanghai (China), 3 July. Participants of the 2nd meeting of the JINR–China Joint Coordination Committee on Cooperation, co-chaired by JINR Director Academician G. Trubnikov and Vice-Minister of Science and Technology of China Long Teng

Vladivostok (Primorsky Krai), 4 July. Visit of JINR Scientific Leader V. Matveev to Far Eastern Federal University. *Photo © Far Eastern Federal University*

nuclear medicine and proton therapy technologies, JINR aims to establish closer cooperation with PRC scientific centres in this field. In turn, JINR invites Chinese colleagues to participate in the ARIADNA applied research collaboration as part of the NICA project.

On 4 July, Far Eastern Federal University (Vladivostok, Primorsky Krai) hosted a meeting to sum up interim results of partnership with JINR as a result of implementation of the quadripartite agreement signed in 2022 by representatives of JINR, FEFU, the Far Eastern Branch of the Russian Academy of Sciences (FEB RAS), and the Government of Primorsky Krai. JINR Scientific Leader Academician V. Matveev represented the Joint Institute at the meeting.

It was noted at the meeting that, as a result of fruitful cooperation between FEFU and JINR, significant progress was made in several key areas: imple-

Dubna, 11 July. Visit to JINR by Ambassador Extraordinary and Plenipotentiary of the State of Israel to the Russian Federation S. Halperin (2nd from right) with accompanying persons

The Veksler and Baldin Laboratory of High Energy Physics, 23–24 July. The workshop on Chinese–Russian cooperation within the NICA-MPD/ITS project

menting new educational programmes, increasing academic mobility and scientific personnel qualification, and popularizing scientific knowledge. One of the most important achievements of joint work was the launch of the Medical Physics Bachelor's course at the Institute of High Technologies and Advanced Materials of FEFU in cooperation with JINR.

At the July meeting of the FEFU Academic Council, JINR Scientific Leader Academician V. Matveev received the title of Honorary Doctor of Far Eastern Federal University as part of the celebration of the centenary of physics and mathematics education in the Far East. The title was awarded in recognition of many years of fruitful cooperation and for the scientist's profound contribution to the development of physics and mathematics education at FEFU. In his speech to colleagues, V. Matveev highlighted scientific and educational aspects of partnership between FEFU and JINR and discussed prospects for its development. Special attention was paid to the plans on constructing a megascience facility, the Russian Photon Source (RPS) Synchrotron, at FEFU on Russky Island (Vladivostok).

At the JINR Information Centre at FEFU, V. Matveev held a meeting with young scientists, students, and teachers, as well as with V. Gorchakov, former Rector of Far Eastern State University (FESU). It was on the initiative of V. Gorchakov that fruitful cooperation between FESU and JINR began in the 1970s.

On 11 July, Ambassador Extraordinary and Plenipotentiary of the State of Israel to the Russian Federation S. Halperin and accompanying persons visited JINR in order to discuss prospects for strengthening cooperation between the Institute and Israel.

The programme of the visit began with an excursion to the objects of JINR's large research infrastructure. At VBLHEP, the guests toured the NICA accelerator complex, including the experimental pavilion of the MPD detector, the Synchrophasotron hall, and the superconducting magnet factory. At FLNR, the delegation got acquainted with the Superheavy Element Factory based on the DC-280 cyclotron and visited the FLNR Centre of Applied Physics.

At the meeting, the parties discussed the achievements and prospects for the development of cooperation between JINR and scientific organizations of Israel. The fruitful collaborative work in relativistic heavy ion physics within the NICA megascience project and the creation of international collaborations of the MPD and BM@N experiments at JINR were emphasized. In addition, the results of joint activity in theoretical physics and as part of other international scientific collaborations, especially CERN, were noted.

On 29 July, Chief of Staff to the Governor of Primorsky Krai and the Government of Primorsky Krai D. Malikova visited JINR. A meeting took place to discuss issues of developing cooperation in training highly qualified personnel.

JINR Scientific Leader Academician V. Matveev hosted the meeting. Among participants were JINR University Centre Director D. Kamanin and Head of a MLIT JINR Sector, Head of the JINR Information Centre at Far Eastern Federal University O. Streltsova.

The parties exchanged views on professional development of school teachers and opportunities for schoolchildren and students, fostering students' research careers and advancing science in the Far East, with an emphasis on technology transfer in

Dubna, 29 July. Chief of Staff to the Governor of Primorsky Krai and the Government of Primorsky Krai D. Malikova (2nd from left) at a meeting at the JINR Directorate

Primorsky Krai under the quadripartite agreement between FEFU, JINR, FEB RAS, and the government of Primorsky Krai signed on 10 October 2022 in Vladivostok.

During her visit to JINR, D. Malikova toured the exhibition "JINR Basic Facilities" at the Mir Cultural Centre and visited the NICA accelerator complex at VBLHEP.

On 3 August, a delegation from the Agency for Strategic Initiatives (ASI) represented by Director General S. Chupsheva and Deputy Director of the ASI Urban Economy Division M. Komkova visited JINR.

A meeting was held at the JINR Directorate to discuss issues of forming modern comfortable urban environment in Dubna and other science cities of Russia. The meeting was attended by JINR Director G. Trubnikov, Head of the Dubna City District M. Tikhomirov, Rector of Dubna State University A. Denikin, and JINR Assistant Director for Development Projects A. Ruzaev.

The ASI Director General spoke on the importance of joint work in creating a master plan for Dubna's social and economic aspects. She noted that this task is crucial in the context of the Russian President's decree to compile a list of 200 large and small cities for which appropriate development strategies will be devised. S. Chupsheva reassured that the Agency would provide the necessary methodological and expert support to Dubna and the Joint Institute in the creation of the master plan. After the meeting, the parties outlined key actions to carry out the agreed tasks and implement future joint projects.

The ASI delegation visited the research infrastructure of the Joint Institute, namely, the sites of the Synchrophasotron and the NICA accelerator complex at VBLHEP, the Centre of Applied Physics at FLNR, and the interactive exhibition "JINR Basic Facilities" at the Mir Cultural Centre.

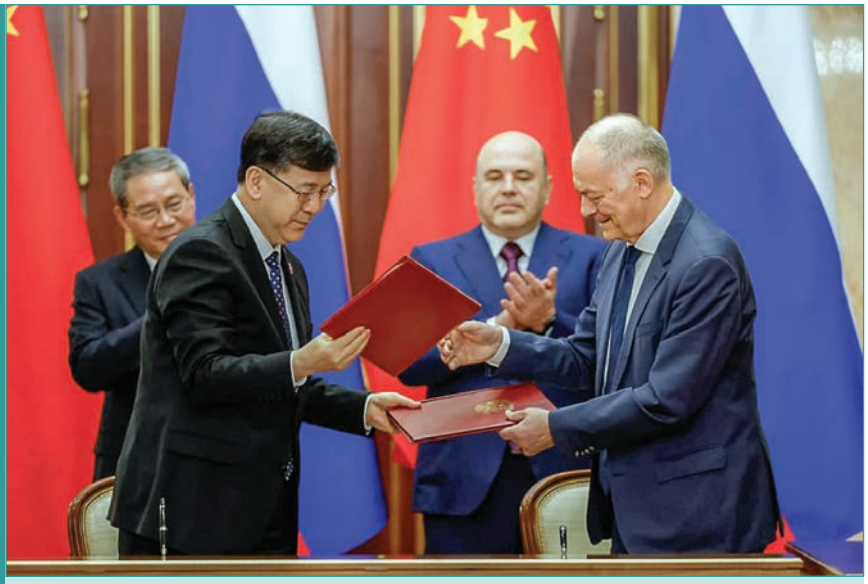
On 21 August, the Joint Institute for Nuclear Research and the Ministry of Science and Technology of the People's Republic of China signed an agreement in Moscow at the House of the Government of the Russian Federation. The document was signed alongside the 29th Regular Meeting between Chinese and Russian Heads of Governments. On the JINR side, the agreement was signed by JINR Vice-Director V. Kekelidze; on the Chinese side, the document was signed by Chinese Minister of Science and Technology Yin Hejun. The signing ceremony was held in the presence of Russian Prime Minister M. Mishustin and Premier of the State Council of the People's Republic of China Li Qiang.

Under the agreement, JINR and the Ministry of Science and Technology of China are planning to jointly finance collaborative fundamental research projects at large scientific facilities. The sides identified eight joint projects in neutrino physics, theoretical and nuclear physics, research and development of microcircuits and detector technologies, the synthesis of new elements, and the study of chemical properties of superheavy elements.

On the part of the Chinese Academy of Sciences, the participants of the selected joint projects with JINR are the Institute of Theoretical Physics, the Institute of High Energy Physics, the Institute of Modern Physics, as well as Tsinghua University and Central China Normal University.

On 3 September, a delegation from the Tavrida Energo Stroy Group of Companies (TES), the general contractor for the construction of the NICA collider building since March 2024, visited JINR.

For more than ten years, TES has been a reliable partner of JINR in the implementation of various infrastructure energy projects. Tavrida Energo Story Group of Companies was represented by TES Director D. Dudarev, Head of the TES-Kirov Branch A. Gu-



Moscow, 21 August. Signing of an agreement between JINR and the Ministry of Science and Technology of the People's Republic of China

ryev, and the project's Commercial Director N. Zabolotsky. On behalf of the leadership of the Joint Institute, JINR Director G. Trubnikov, NICA Project Leader V. Kekelidze, and JINR Deputy Chief Engineer A. Dudarev attended the meeting.

At the meeting, issues related to completing tasks and searching for the solutions required to complete the construction works at the facility on time were discussed. Together with representatives of the Institute, the general contractor held an off-site meeting at VBLHEP to inspect the accelerator complex, and the status of ongoing work was presented.

Following the results of the visit, the most complex sections of the facility were defined. Such sections require special attention and additional control in terms of completing the tasks. A joint decision was made to deepen the interaction of JINR offices and departments and the general contractor for timely completion of the tasks of the construction and commissioning works at the NICA complex.

On 9 September, a festive event dedicated to the beginning of the new academic year took place in the academic building of the MSU Branch in Dubna.

Dubna, 3 September. Visit to JINR by the delegation from the Tavrida Energo Stroy Group of Companies, the general contractor for construction of the NICA collider building

Opening the event, Deputy Director of the MSU Branch in Dubna A. Olshevsky congratulated students and teachers on the beginning of the academic year, emphasizing the importance of scientific and educational cooperation between MSU and JINR.

This year, 11 students were enrolled in the fields "Elementary Particle Physics" and "Fundamental and Applied Nuclear Physics", of which 10 received budget places. The geographical spectrum of the new intake of students covers such cities of Russia as Dubna, Irkutsk, Kazan, Samara, Vladikavkaz, and Voronezh.

In his speech, Director of the MSU Branch in Dubna, Corresponding Member of the Russian Academy of Sciences E. Boos spoke about the history of the establishment of the institution, the events that preceded its appearance on the map of Dubna in the middle of the 20th century, and plans for the development of the Branch in the coming years.

Academician G. Trubnikov, Director of JINR, Head of the programme "Fundamental and Applied Nuclear Physics" at the MSU Branch in Dubna, made a presentation on modern JINR projects and research, as well as the history of scientific and educational cooperation with Moscow State University.

Congratulating the students, MSU Vice-Rector S. Bushev noted that Dubna has a unique combination of high scientific potential and a comfortable urban environment for living.

A ceremony of awarding student cards to first-year undergraduates took place in a festive atmosphere, after which an excursion to VBLHEP was organized for all students and teachers, where they visited the site of the NICA accelerator complex.

On 13 September, the winners of the Oganesson Prize were announced at the 136th session of the JINR Scientific Council. The Prize was created at the suggestion and expense of Academician of the Russian Academy of Sciences Yu. Oganessian. The Prize founders are Yu. Oganessian and JINR.

Speaking at the session of the Scientific Council, JINR Director Academician G. Trubnikov noted that the Prize is awarded annually for significant achievements in theoretical and experimental research in physics, chemistry, biology, and applied problems, as well as for creative activities in the field of education and the popularization of science.

The winners of the 2024 Oganesson Prize are:

• A. Nurmukhanbetova (Nazarbayev University, Republic of Kazakhstan), Head of the Nazarbayev University Research and Innovation System Laboratory (NURIS), for the development and implementation of a new programme for the study of the lightest nuclei at the low-energy ion accelerator (DC-60);

• G. Knyazheva (FLNR JINR), Senior Researcher, for pioneering work on the observation and study of the quasi-fission process of the heaviest nuclei;

• T. Chernigovskaya, Director of the Institute of Cognitive Research of Saint Petersburg State University (Russia), Professor, Honoured Worker of Higher Education and Honoured Scientist of the Russian Federation, for outstanding contribution to the popularization of scientific knowledge and the develop-

Dubna, 16 September. Visit to JINR by Ambassador Extraordinary and Plenipotentiary of the Republic of Belarus to the Russian Federation A. Rogozhnik (centre) with accompanying persons

Vienna (Austria), 18 September. JINR Delegation headed by Vice-Director L. Kostov at the meeting with IAEA Deputy Director General M. Chudakov (centre) within the 68th IAEA General Conference

ment of interdisciplinary research at the intersection of neuroscience, linguistics, and psychology;

• Yu. Zolotov, RAS Academician, Chief Researcher at the MSU Department of Analytical Chemistry, Chief Researcher at the Institute of General and Inorganic Chemistry (Russia), for outstanding scientific work in analytical chemistry, for significant personal contribution to the training of young scientists, specialists, and highly qualified personnel;

• Z. Vilakazi, Vice-Chancellor and Principal of the University of the Witwatersrand (RSA), for significant contribution to the development of scientific cooperation between South Africa and JINR in nuclear reactions, accelerator technologies, and relativistic nuclear physics.

The ceremony of awarding the winners of the Oganesson Prize will take place in February 2025 in Moscow.

On 16 September, Ambassador Extraordinary and Plenipotentiary of the Republic of Belarus to the Russian Federation A. Rogozhnik with accompanying persons visited the Joint Institute for Nuclear Research.

At the meeting with the leadership of the Institute, the parties discussed prospects for the development of comprehensive cooperation between JINR and Belarus.

The guests made an excursion to VBLHEP, where they got acquainted with the implementation of the NICA megascience project, and also got introduced to the wide range of Institute's research at the interactive exhibition "JINR Basic Facilities" at the JINR Mir Cultural Centre.

During the meeting with the JINR Directorate, a discussion took place regarding issues of strengthening cooperation with the leading scientific centres of Belarus in the fields of physics, optics, microelectronics, and medicine.

On 16–20 September, JINR's delegation, led by Vice-Director L. Kostov, took part as observers in the 68th General Conference of the International Atomic Energy Agency (IAEA) , which took place in Vienna (Austria).

On 18 September, the JINR delegation met with IAEA Deputy Director General M. Chudakov. Both parties noted the improvement of cooperation and the regular interactions between the organizations, particularly the participation of IAEA representatives as observers in the JINR CP sessions.

Considerable attention was paid to discussing the implementation of the updated framework cooperation agreement between JINR and the IAEA signed on 27 September 2022. Among other things, the document provides for joint development of personnel training, improvement of research infrastructure, and operation of nuclear research reactors and particle accelerators, including expert support in the creation of new facilities. During the talks, the parties considered practical steps to implement the intentions of the Lise Meitner Programme and made progress in the partnership between JINR and the IAEA to launch the Internet Reactor Laboratory project.

Alongside the IAEA General Conference, the JINR delegation held bilateral meetings with representatives of more than a dozen countries and international organizations. In addition, JINR delegates joined a number of satellite events of the General Conference.

On 17 September, a round table was held at the JINR Scientists' Club with the participation of representatives of the National Academy of Sciences of Belarus.

The Belarussian delegation included Chief Scientific Secretary of the National Academy of Sciences of Belarus V. Gursky, Academician-Secretary of the

Department of Physical and Technical Sciences, Responsible from the National Academy of Sciences of Belarus for contacts with JINR S. Shcherbakov, Academician-Secretary of the Department of Physics, Mathematics, Computer Science A. Shumilin, Director General of the State Scientific and Production Association "Optics, Optoelectronics, and Laser Technology" M. Bogdanovich, and Senior Specialist of the Staff of the National Academy of Sciences of Belarus O. Grigorieva.

The Joint Institute was represented at the meeting by JINR Director G. Trubnikov, JINR Vice-Director, Responsible Head of JINR for contacts with the Republic of Belarus V. Kekelidze, Chief Scientific Secretary of the Institute S. Nedelko, Directors of JINR laboratories: S. Sidorchuk (FLNR), E. Lychagin (FLNP), E. Yakushev (DLNP), Head of the VBLHEP Division of Physics at Colliding Beams D. Peshekhonov, and Head of the DLNP Sector of Detecting Systems, Processing and Analysis of Physical Information, Head of the national group of the Republic of Belarus at JINR Yu. Kulchitsky.

Proposals on joining scientific organizations of the National Academy of Sciences of the Republic of Belarus to the Baikal-GVD project and their participation in the creation of the MSC-230 medical proton cyclotron, opportunities for cooperation in the production of optical fiber, microelectronics, software development and analysis of experimental data were considered; the participation of Belarussian schoolchildren and teachers in JINR educational programmes and the possibility of exchanging specialists in narrow areas were discussed between the Scientific Institution of Belarus JIPNR–Sosny and FLNP JINR.

During the visit to JINR, the delegation of the NAS of Belarus visited FLNP and DLNP, the Superheavy Element Factory and the Nanocentre at FLNR, the NICA accelerator complex and the superconducting magnet factory at VBLHEP. Fruitful working meetings, aimed at expanding cooperation, were held with representatives of the leadership of these laboratories.

On 19–22 September, the JINR delegation visited Mongolia. The JINR representatives took part in an international conference dedicated to the 50th anniversary of the Institute of Mathematics and Digital Technology of the Mongolian Academy of Sciences. At the conference, which brought together representatives of institutes from China, France, Japan, Mongolia, Portugal, Russia, South Africa, the USA and other countries, MLIT Scientific Leader V. Korenkov, LRB Director, Responsible Head of JINR for contacts with Mongolia A. Bugay, MLIT Deputy Director O. Chuluunbaatar, and MLIT Leading Researcher A. Gusev made presentations.

The JINR delegation visited the Institute of Mathematics and Digital Technology, the Institute of Physics and Technology of the Mongolian Academy of Sciences (MAS), and the Centre for Nuclear Physics Research of the Mongolian State University, where they got acquainted with scientific programmes and research infrastructure, in particular, with a computing cluster, ionizing radiation sources, and a radiochemical laboratory under construction. At the Centre for Nuclear Research, the delegation visited the memorial office of Academician N. Sodnom, President of the Mongolian Academy of Sciences and Rector of the Mongolian State University, who served as Vice-Director of JINR in 1967–1973. A meeting was held with well-known Mongolian scientists who worked at JINR.

At the round table with the heads of institutes and members of the MAS, chaired by the Plenipotentiary of the Government of Mongolia to JINR, Academician

Dubna, 21 September. Visit to JINR by representatives of the leadership of the Academy of Sciences of the Republic of Uzbekistan

Dubna, 27 September. Participants of the International Youth Acceleration Programme "Business Incubator of the Shanghai Cooperation Organization" on an excursion to VBLHEP

S. Davaa, a number of agreements were reached on intensifying interaction between JINR and Mongolian research teams, participation in educational programmes and using opportunities to attract associate staff. The parties agreed on the development of the future Information Centre of the Joint Institute in Mongolia and the organization of events within the framework of JINR Days in Mongolia in 2025.

On 21 September, JINR received a visit from representatives of the leadership of the Academy of Sciences of the Republic of Uzbekistan (AS RUz): AS RUz Acting President S. Mirzaev and Vice-President of the Academy G. Bahadirov.

JINR Vice-Director S. Dmitriev welcomed the delegation. He expressed condolences on behalf of the Institute's Directorate on the passing away of AS RUz President, Plenipotentiary of the Government of the Republic of Uzbekistan to JINR, member of the Scientific Council of the Institute B. Yuldashev. The parties discussed bilateral organizational issues, including the participation of the delegation of Uzbekistan in the upcoming meeting of the Finance Committee and the session of the Committee of Plenipotentiaries, scheduled for November.

Another topic for discussion was bilateral cooperation prospects in fundamental and applied research. In particular, the parties expressed interest in developing medical radioisotopes, studying cultural heritage sites using neutron activation analysis and radiography, and the use of JINR precision inclinometers at seismic stations in Uzbekistan in order to predict earthquakes.

As part of the visit, the AS RUz delegation visited VBLHEP, FLNR, FLNP, and MLIT JINR, and got introduced to the infrastructure of the Institute and the range of research carried out.

On 24–27 September, the final part of the International Youth Acceleration Programme "Business Incubator of the Shanghai Cooperation Organization (SCO)" was held in Moscow and the Moscow Region. The programme is supported by the President of the Russian Federation.

As part of the first day of the programme in Dubna at the Dubna SEZ Congress Centre, a report "Proton therapy. JINR experience and suggestions" was made by JINR Assistant Chief Engineer S. Shirkov. On the second day of the intensive, the participants visited VBLHEP and MLIT JINR, where they got acquainted with the flagship NICA megascience project, the JINR Multifunctional Information and Computing Complex, and the Govorun supercomputer, as well as the interactive exhibition "JINR Basic Facilities" at the Mir Cultural Centre.

Fifty entrepreneurs aged 18 to 35 from Belarus, China, India, Kazakhstan, Kyrgyzstan, Pakistan, Russia, and Uzbekistan took part in the acceleration programme, leading individual projects, startups and firms in various fields: from applied physics and chemistry to IT and pedagogy, from pharmaceuticals to restaurant business and logistics.

On 26 September, a Vietnamese delegation headed by the Minister of Science and Technology of the Socialist Republic of Vietnam (SRV), Huỳnh Thành Đạt, visited JINR. The main topics of discussion were the training of personnel for the research reactor planned in Vietnam, the involvement of Vietnamese employees in key JINR projects, and JINR's support for the project to create an accelerator complex in Hanoi.

A meeting of the Joint Coordination Committee (JCC) on JINR–Vietnam scientific projects was held at the ICH JINR. JINR Co-Chairman of the JCC B. Sharkov spoke about the progress of work on the implementation of joint projects and grants from the Plenipotentiary of the Government of the SRV. Special attention is focused on the implementation of the project to create a joint Vinatom–JINR laboratory based on a research reactor, which is planned to be built in the south of Vietnam as part of the Vietnam–Rosatom programme. The organization and conduct of the JEMS course for representatives of Southeast Asian countries and Vietnam's participation in other JINR educational programmes were discussed. At the meeting, diplomas on completion of the international student internship, held in September, were also awarded to its graduates from Vietnam. The report of the Head of the Vietnamese community in JINR was heard.

In his speech, Co-Chairman of the JCC, Vice-President of the Vietnam Academy of Science and Technology, Plenipotentiary of the Government of the SRV to JINR Trần Tuấn Anh expressed gratitude to the leadership of the Institute for the support for hurricane relief in Vietnam.

President of the Vietnam Atomic Energy Institute (Vinatom), member of the JINR Scientific Council Trần Chí Thành expressed the interest of the Vietnamese side in JINR's active participation in personnel training in 2025–2030 for the future reactor, one of the four channels for applied research of which will be allocated specifically for JINR scientists, and also asked to consider the possibility of contributing to the selection and supply of equipment for the new accelerator centre, which will be located in the suburbs of Hanoi.

Director of the Radiation and Nuclear Safety Department of the Ministry of Science and Technology of Vietnam Nguyễn Tuấn Khải noted, in particular, that, in his opinion, JINR could participate in the creation of a roadmap for the effective operation of the new reactor after its commissioning for Vinatom and the countries of Southeast Asia.

At the end of the meeting, JINR Director G.Trubnikov confirmed the interest of the Joint Institute in creating a research channel at the future reactor and the project as a whole, in participating in the creation of equipment for the accelerator centre and supported the proposal on the need for active internships for Vietnamese specialists at JINR, including holding student schools, conferences, and professional development events in full-time and remote formats based on the future Infocentre.

The Vietnamese delegation visited FLNR and VBLHEP JINR, where they got acquainted with the flagship facilities of the Institute: the Superheavy Element Factory and the NICA accelerator complex, as well as the work of the FLNR Nanocentre.

On 26 September, a meeting of heads of JINR joint projects and scientific organizations and universities of the Republic of South Africa was held. Currently, the RSA–JINR cooperation programme in-

Dubna, 26 September. A Vietnamese delegation headed by Minister of Science and Technology of the Socialist Republic of Vietnam Huỳnh Thành Đạt (2nd from right, 1st row) visiting JINR

Dubna, 26 September. Meeting of heads of JINR joint projects and scientific organizations and universities of the Republic of South Africa

Dubna, 7–11 October. Participants of the programme "Introduction for the Plenipotentiaries' Offices and Officials Responsible for Liaison with JINR"

cludes more than 20 projects that cover most of the thematic areas of JINR research.

Coordinator of RSA–JINR cooperation, iThemba LABS Deputy Director R. Nchodu stressed the great interest of South African scientists in further developing ties with the Joint Institute and spoke about the next steps planned in this direction. Work is underway to consolidate the interests of RSA universities in the format of consortia for joint participation in major JINR projects, training in nuclear technology, radiobiology, accelerator technology and a number of other areas. In 2024, South African students took part in two streams of international student practice conducted by UC JINR.

During the meeting, the joint preparation of the International African Symposium on Exotic Nuclei (IASEN-2024) with JINR was discussed, within which a regular meeting of RSA–JINR Joint Coordination Committee will be held, and the opening of the JINR Information Centre at iThemba LABS is also planned.

From 7 to 11 October, JINR hosted for the first time the programme "Introduction for the Plenipotentiaries' Offices and Officials Responsible for Liaison with JINR" , which gathered nine representatives of scientific centres of Armenia, Azerbaijan, Belarus, Cuba, Egypt, Georgia, Mongolia, Serbia, and Uzbekistan.

The main goal of the event was to provide representatives of the offices of the Plenipotentiaries of the JINR Member States with most complete information about the establishment and implementation of the Institute's research policy, various aspects of its administrative and organizational activities, research and social infrastructure, educational programmes, and innovative projects.

For five days, the participants got acquainted with the laboratories and the largest research facilities of the Institute through tours, listened to lectures by representatives of the offices and departments, participated in discussions and meetings with laboratory directors and heads of the national groups.

On the last day, a round table with representatives of Institute's leadership took place. JINR Vice-Director L. Kostov stressed the importance and relevance of organizing this programme to optimize the cooperation of JINR's Departments with the offices of the Plenipotentiaries of the Member States. The guests shared their impressions gained during their visit to the Institute.

On 7–11 October, the 5th International Scientific Forum "Nuclear Science and Technology", organized with the participation of the Ministry of Energy and the Ministry of Science and Higher Education of the Republic of Kazakhstan (RK), CERN, and leading scientific centres and educational organizations of RK, was held at Al-Farabi Kazakh National University (KazNU). Staff members of the Joint Institute actively participated in the forum.

On 3–4 October, ahead of the international forum, JINR employees gave popular science lectures for students of secondary school No. 64 in Almaty and KazNU. In addition, the schoolchildren and students learned about opportunities to participate in the JINR international schools, internships, scientific conferences, and tours of the Institute's largest research facilities.

At the opening of the event on 7 October, President of the National Academy of Sciences under the RK President A. Kurishbayev acknowledged the progress in cooperation between the Republic's scientific community and world leading research centres, including the Joint Institute. FLNR JINR Deputy Scientific Leader M. Itkis discussed the history of research in synthesis of superheavy elements. During his speech at the final session of the forum, Head of the INP Laboratory of Nuclear Processes T. Zholdybayev stressed the role of JINR in training Kazakhstan young specialists and helping them grow as researchers.

During the forum, the Joint Institute employees delivered more than 50 reports. Their reports covered topical areas of fundamental and applied nuclear physics, nuclear energy, radiation ecology, and the application of radiation technologies in medicine and industry.

On 10–14 October, in Haikou on Hainan Island (China), the 33rd General Assembly of the International Union of Pure and Applied Physics (IUPAP) was held. JINR Director Academician G. Trubnikov and Special Representative of the JINR Director for Cooperation with International and Russian Scientific Organizations Academician B. Sharkov participated in it. JINR, as an international intergovernmental

Almaty (Kazakhstan), 7–11 October. Participants of the 5th International Scientific Forum "Nuclear Science and Technology"

Haikou (China), 10–14 October. The 33rd General Assembly of the International Union of Pure and Applied Physics

organization, acts as an Independent Corporate Associate Member of the IUPAP, on a level with CERN.

Along with the participation of the JINR delegation in the General Assembly, several meetings were held with leaders of large scientific organizations on joint participation in international research projects. In particular, G. Trubnikov held talks with members of the CERN Council to discuss JINR's further participation in CERN projects. In addition, meetings took place with the heads of major global and national infrastructure projects and outstanding scientists, including Nobel laureates in physics B. Barish (gravitational waves), T. Kajita (neutrino oscillations), and S. Ting (discovery of the *J*/ψ meson).

At the 33rd General Assembly of IUPAP, Academician B. Sharkov was re-elected for a second term

Hanoi (Vietnam), 13–19 October. JINR delegation's working visit to Vietnam. Meeting at the Vietnam Atomic Energy Institute (Vinatom)

Dubna, 15 October. After the signing of the JINR cooperation agreements with the National Nuclear Energy Commission of Brazil and the Federal University of Southern Bahia

as an Officer serving as a Treasurer. Three JINR candidates were appointed members of the IUPAP commissions. VBLHEP Chief Researcher R. Lednický will represent the Institute in the Commission on Elementary Particle Physics. Senior Researcher at the Flerov Laboratory of Nuclear Reactions G. Knyazheva was recommended by FLNR and elected to the Commission on Nuclear Physics; LRB Director A. Bugay joined the Commission on Biological Physics.

On 15 October, two new cooperation agreements were signed at JINR with the National Nuclear Energy Commission of Brazil (CNEN) and the Federal University of Southern Bahia (UFSB) during the visit of representatives of higher education institutions of Brazil to Dubna.

As part of a round table with JINR Directorate and Laboratories' leaders, cooperation agreements were signed that open up new opportunities for joint research and development of scientific and educational programmes. JINR Director G. Trubnikov spoke in detail about the organization of Institute's activities, the major areas of research conducted at the laboratories, and the modern JINR scientific infrastructure. Special focus was placed on implementing training programmes for young specialists to participate in international research projects.

As part of their introduction to the scientific infrastructure of the Joint Institute, the guests from Latin America visited the sites of the NICA accelerator complex at VBLHEP, the Centre of Applied Physics at FLNR and the interactive exhibition "JINR Basic Facilities" at the Mir Cultural Centre.

On 29 October, the winners of the annual Moscow Region Governor's Prize in science, technology, engineering, and innovation were announced. Among the 15 prizewinners are two representatives of JINR: Candidate of Technical Sciences, Head of the VBLHEP Scientific and Experimental Department of Superconducting Magnets and Technologies D. Nikiforov and Candidate of Physics and Mathematics, a researcher at the BLTP Sector of Nuclear Reactions and Nucleus Structure E. Mardyban.

D. Nikiforov presented the research titled "Advanced cryogenic systems for the NICA accelerator complex". The author made a decisive contribution to a number of works carried out as part of NICA and other projects: the development and commissioning of a cryoprotection system for test in superconducting (SC) magnets; the creation of a mathematical model computing the cooling time of the Nuclotron SC magnets; the technology development and cryogenic testing of low-current input leads for correction magnets of the booster synchrotron and rings of the NICA collider.

E. Mardyban received the Governor's Prize for the study of the structure and properties of atomic nuclei within the collective nuclear models. The author conducted a number of original scientific studies on the structure of heavy atomic nuclei under various deformations and at different excitation energies.

On 6 November, the Ministry of Science and Higher Education of the Russian Federation hosted a meeting of the Supervisory Board of the NICA Project dedicated to discussing the progress of the megascience project of the Joint Institute for Nucle-

Winners of the annual Moscow Region Governor's Prize in science, technology, engineering, and innovation — JINR employees D. Nikiforov (left) and E. Mardyban

ar Research. The Supervisory Board is co-chaired by JINR Director G. Trubnikov and Russian Deputy Minister of Science and Higher Education A. Omelchuk.

Vice-Director of the Joint Institute for Nuclear Research, NICA Megascience Project Leader V. Kekelidze delivered a presentation on the status of NICA. He highlighted the progress in the project implementation, noting that the magnetic cryostat system of the accelerator complex had been successfully installed, and a phased technological run of all major collider systems had been initiated.

At the end of the meeting, the members of the Council approved the updated work plan for the construction and launch of the basic configuration of the VBLHEP accelerator complex, supported the measures taken by the Joint Institute to minimize risks and optimize the completion time of the facility in accordance with the approved plan, and con-

Moscow, 6 November. Meeting of the Supervisory Board of the NICA Project, dedicated to discussing the progress of the JINR megascience project

firmed the intention of the Institute to accomplish the project on schedule.

On 10–15 November, a delegation of JINR was on a working visit in Minsk where it visited organizations of the National Academy of Sciences of Belarus. Representatives of the institutes of the NAS of Belarus told the guests about the history and the main trends of scientific and industrial activities of their organizations and took part in negotiations on cooperation.

On 13 November, a round table discussion was held dedicated to prospects for development of cooperation between JINR and NAS of Belarus, with the participation of the leaders of the Academy and its organizations, as well as directors and leading scientists of the JINR Laboratories. Chair of the Belarussian NAS Presidium V. Gusakov and FLNR JINR Director S. Sidorchuk greeted the participants of the discussion. Reports by the JINR staff members presented almost all areas of the Institute's activities.

Negotiations were held between Chair of the Presidium of NAS of Belarus V. Gusakov and JINR Director G. Trubnikov, where possible steps towards strengthening cooperation in fundamental and applied science were discussed.

On 14 November, ahead of the session of the Committee of Plenipotentiaries, Director of the Joint Institute G. Trubnikov met with Rector of the Belarussian State University (BSU) A. Karol at the BSU. Special attention was paid to applied nuclear physics projects for biomedicine, information technology, and agro-industrial complex, including training high-quality specialists, the programme of double diplomas, and issues of organizing meetings in the near future on further cooperation and plans of joint work.

On 11 November, the Institute of Theoretical Physics of the Chinese Academy of Sciences (ITP CAS) and the Bogoliubov Laboratory of Theoretical Physics of JINR signed a cooperation agreement in Beijing. BLTP JINR Director, Corresponding Member of the Russian Academy of Sciences, Professor D. Kazakov signed the agreement on behalf of JINR, while ITP CAS was represented by Director of the Institute, Professor Shang-Gui Zhou.

The agreement will strengthen scientific connections and contribute to the development of international research cooperation in theoretical physics. The parties plan to hold scientific schools, conferences, and meetings. In addition, active cooperation will include establishing new scientific connections between employees of the organizations, conducting joint research, publishing articles in co-authorship, exchanging visits of scientists, students, and postgraduates.

To coordinate the work under the agreement, a steering committee was established. It includes two employees from both organizations who will annually review applications for joint research projects and evaluate the success of ongoing activities.

On 18 November, Ambassador Extraordinary and Plenipotentiary of the Republic of Azerbaijan to the Russian Federation R. Mustafayev and accompanying persons visited the Joint Institute for Nuclear Research.

Minsk (Belarus), 13 November. A round table dedicated to the prospects of cooperation between JINR and NAS of Belarus with the participation of JINR laboratories directors and leading specialists

Dubna, 18 November. Visit to JINR of Ambassador Extraordinary and Plenipotentiary of the Republic of Azerbaijan to the Russian Federation R. Mustafayev (left) with accompanying persons. On an excursion to VBLHEP

At the meeting at the JINR Directorate, the parties discussed the issues of enhancing cooperation between Azerbaijan scientific institutions and JINR, with special attention paid to training highly qualified personnel for the Republic of Azerbaijan and enchancing digital and big data collaborations.

It was stressed at the meeting that JINR has maintained ties with the national scientific centres of Azerbaijan throughout its history. Scientists of the Joint Institute work with their Azerbaijan colleagues in many research areas and projects of the Institute, including the NICA accelerator complex and the IBR-2 research reactor, theoretical research and studies on neutrino physics and astrophysics, and the JINR information and computing infrastructure. Specialists from Azerbaijan are trained and interned in Dubna.

R. Mustafayev met with representatives of the National Group of Azerbaijan at JINR. The delegation visited the Laboratories of High Energy Physics and Neutron Physics at JINR, including the MPD pavilion of the NICA accelerator complex. A tour of the interactive exhibition "JINR Basic Facilities" was organized for Embassy representatives at the Mir Cultural Centre.

On 22 November, President of the Russian Academy of Sciences G. Krasnikov visited the Joint Institute for Nuclear Research together with RAS Vice-Presidents V. Panchenko and S. Kalmykov.

At a meeting at the Institute's Directorate, JINR Director G. Trubnikov told G. Krasnikov about the progress of the JINR megascience projects, the NICA accelerator complex and the Baikal-GVD neutrino telescope. The parties discussed the opportunity to create a federal programme for the study of the basic properties of matter, the organization of a large IT infrastructure uniting various scientific centres, and issues of support and retention of scientific employees.

During the visit, the RAS representatives toured two of the largest JINR scientific infrastructure facilities: the NICA accelerator complex, including the Synchrophasotron hall, the MPD detector pavilion at VBLHEP, and the Superheavy Element Factory at FLNR. In addition, they got acquainted with plans of large-scale physical experiments at these facilities.

On 25 November, representatives of the Joint Institute for Nuclear Research paid a visit to the University of Debrecen (Hungary), as part of which a trilateral agreement was signed with the University of Debrecen and the Institute of Nuclear Research of the Hungarian Academy of Sciences (ATOMKI) on strengthening ties in personnel training, academic mobility programmes, collaborative research, and organization of joint events, including training courses and conferences.

On behalf of JINR, Chief Scientific Secretary S. Nedelko and Deputy Director of the Flerov Laboratory of Neutron Physics for Scientific Work S. Kulikov attended the meeting. The University of Debrecen was represented by Pro-Rector General K. Pető, Director for Coordination and Strategy O. Kiszil, and Dean of the Faculty of Science and Technology F. Kun. Deputy Director of the Institute of Nuclear Research G. Lévai also attended the event.

As part of the event, the JINR representatives visited the Faculty of Science and Technology of the University of Debrecen and the Institute of Nuclear Research.

Debrecen (Hungary), 25 November. A trilateral agreement has been signed with the University of Debrecen and the Institute of Nuclear Research (ATOMKI). *Photo: © unideb.hu*

On 25–27 November, a delegation of JINR, headed by the Institute Director G. Trubnikov, had a working visit to the Republic of Azerbaijan.

On the first day of the visit, a meeting was organized of the JINR delegation with President of the Azerbaijan National Academy of Sciences (ANAS) I. Habbibayli, where the sides informed each other about strategic trends of the development of ANAS and JINR and discussed priority tasks in the cooperation.

At the National Oncology Centre (NOC) of the Ministry of Health of the Republic of Azerbaijan, a meeting was organized of the JINR delegation with NOC General Directot Academician J. Aliev. The participants discussed the status and prospects for the development of nuclear medicine in Azerbaijan, as well as current methods of cancer prevention and treatment. Director of the Centre F. Novruzov introduced the capabilities of the Nuclear Medicine Department to the guests, including SPECT and PET diagnostics, advanced approaches to working with patients and the production of radiopharmaceuticals.

At the meeting of the JINR delegation with the representatives of the Karaev Institute of Physiology of the Azerbaijan Ministry of Science and Education, the goals and objectives of implementing a joint research project dedicated to the investigation of promising medicinal products of plant origin were discussed. The samples provided by the Institute of Physiology staff are scheduled to be included in the programme of experimental measurements at the IBR-2 reactor, and investigations of the potential radioprotective effect of the substances in question will be carried out on cell cultures and laboratory animals.

During G. Trubnikov's visit to the Ministry of Science and Education of the Republic of Azerbaijan, a meeting was held with Deputy Minister F. Gurbanov, the subject of which was a detailed discussion of priority areas of cooperation and prospects for strengthening the cooperation of scientific and scientific-educational organizations of Azerbaijan and JINR. The meeting was attended by Plenipotentiary of the Government of Azerbaijan to JINR A. Gashimov.

On 26 November, at Khazar University, a solemn ceremony of signing an agreement on cooperation in the field of education and science between the the two organizations was held. The document was signed by JINR Director G. Trubnikov and the founder of Khazar University H. Isayev.

During these days, a seminar was organized for students and staff of the university, where G. Trubnikov presented general information about the research activities of the Institute and the staff members of LRB, FLNP and DLNP made reports on research in the field of life sciences. The event ended with a discussion of the prospects for joint activities in this area. Rector of Khazar University I. Khalilova, Head of the Engineered Biomaterials Research Centre (EBMRC) S. Davaran, Dean of the Faculty of Life Sciences J. Eldarova, Dean of the Faculty of Physics and Electronics F. Tatardar, and Dean of the School of Sciences and Engineering F. Afandi participated in the discussion. Following the discussions, the parties agreed to carry out joint interdisciplinary research in the field of multicomponent radiation therapy for oncological diseases.

On 29 November, a meeting of the JINR Science and Technology Council (STC) took place at the JINR International Conference Hall. STC members discussed the task of attracting highly qualified scientific personnel to the Joint Institute.

JINR Director G. Trubnikov presented the Institute's current activities. He spoke about the main achievements and results at each laboratory for the discussed period, touched upon issues of staff composition of the Institute, activities of the JINR Dissertation Council, wage increase for the staff members — scientists and engineers. Among the highlights of the last months of JINR's life, the Director of the Institute noted the AYSS-2024 conference, which brought together more than 260 young people from 17 countries and the first issue of the JINR peer-reviewed online journal "Natural Science Review" (the Chief Editor is JINR Scientific Leader V. Matveev). G. Trubnikov urged employees to submit more articles for publication. He also spoke about the JINR Start-Ups innovation project competition that aims at implementing 5–10 small technological projects annually; the JINR infrastructure facilities undergoing repairs, including gyms, exhibition spaces, the Ratmino Dispensary, and the Dubna Resort House in Alushta; elections to the Council of Deputies of the city district that were held in Dubna where five JINR representatives joined the City Council; the development of the city's master plan and its development strategy together with other enterprises.

Part of the strategic plan of the city is the Dubna University campus, an International Science and Technology Park planned to be built on the site of the Dubna Special Economic Zone located on the left bank of the Volga River. Acting Rector of Dubna State University A. Denikin provided further details regarding the project.

JINR University Centre Director D. Kamanin presented the UC programme of activities and prospects for the development of the centre's educational projects.

The UC will solve tasks connected to the expectations of the JINR Laboratories, including the synchronization of curricula of the JINR-based departments in various leading universities of Russia, examinations required for the Candidate's degree, postgraduate studies, assistance in opening the Radiochemistry Department at the Moscow State University Branch in Dubna, qualified personnel training, occupational safety training, Russian language classes for employees, and other tasks.

JINR is currently working on a new University Centre regulation, prompted by the need for the UC Council to resume its activities in order to determine the University Centre development strategy. The Council will include the Institute's Director, the UC Director, representatives of the JINR Laboratories, heads of the JINR-based Departments, representatives of the Directorate and leadership of the Institute, heads of the Association of Young Scientists and Specialists and the JINR Council of National Groups. Simultaneously, a working group of the UC Council for urgent tasks should be established.

A discussion on the issues of the STC agenda was held.

On 4 December, a delegation from the Embassy of the People's Republic of China in the Russian Federation visited JINR.

JINR Scientific Leader Academician V. Matveev highlighted the exceptional significance of the visit

Baku (Azerbaijan), 25–27 November. A working visit of the JINR delegation to the Republic of Azerbaijan. At a meeting with Deputy Minister of Science and Education of the Republic of Azerbaijan F. Gurbanov. *Photo: © edu.gov.az*

The Veksler and Baldin Laboratory of High Energy Physics, 26 September. Workshop on Superconducting Cavities and Fast-Cycling Magnets as part of cooperation between JINR and the Institute of Modern Physics of the Chinese Academy of Sciences

of the representatives of the Embassy of the People's Republic of China. He also recalled the significant historical contribution of the PRC to the establishment of JINR and expressed hope for expanding cooperation.

The sides discussed prospects of the cooperation development in fundamental science, implementation of new joint projects and expanding research opportunities, and expressed mutual interest in deepening of partner relations and development of the fruitful dialogue in science and technology. The guests highly evaluated the efficiency of the development of mechanisms of interaction and the general level of cooperation between JINR and China.

During the visit, the Chinese delegation became acquainted with the scientific infrastructure of JINR and saw the sites of the NICA accelerator complex at the Veksler and Baldin Laboratory of High En-

Dubna, 4 December. Visit to JINR by the delegation of the Embassy of the People's Republic of China in the Russian Federation

ergy Physics, the Superheavy Element Factory and the Centre of Applied Physics at the the Flerov Laboratory of Nuclear Reactions, and the interactive exhibition "JINR Basic Facilities" at the Mir Cultural Centre.

In conclusion of the visit, the delegation of the Chinese Embassy had a meeting with JINR Director Academician G. Trubnikov.

In December, a delegation of the Joint Institute for Nuclear Research, headed by Director G. Trubnikov, participated in the 23rd meeting of the JINR–RSA Joint Coordination Committee held at the NRF: iThemba LABS (iTL), the accelerator centre of South Africa.

The meeting's agenda was devoted to strategic issues of further cooperation development, analysis of the execution and financing of current projects, organization of competitions for new projects, and a rich joint event plan. Deputy CEO of the National Research Foundation (NRF) of South Africa A. Paterson co-chaired the meeting of the Committee from the South African side.

A workshop preceding the Committee meeting focused on discussing the implementation of accelerator technology and radiobiology projects.

The Committee members expressed satisfaction with the current results of the work and highlighted the increasing number of joint projects and collaborating scientists and organizations. Special attention was paid to new cooperation areas. The parties discussed a programme of events aimed at strengthening the partnership further and celebrating the 20th anniversary of South Africa's associate membership in JINR and the 70th anniversary of the Institute's founding.

On 9–13 December, the 2nd International African Symposium on Exotic Nuclei (IASEN-2024) was held in Gordons Bay (Cape Town, RSA), organized by the accelerator centre of the Republic of South Africa NRF: iThemba LABS and JINR. The main focus of the event was on the investigation of nuclei in extreme states, in particular, at the limits of nuclear stability (from superlight neutron- and proton-rich to superheavy nuclei). More than 120 specialists from states of Europe, Africa, Asia, North and South America took part in the symposium. JINR was represented by over 20 specialists from FLNR, DLNP, BLTP, VBLHEP, MLIT and UC.

JINR Director Academician G. Trubnikov took part in the festive opening of the international symposium. At the plenary session of the first day, he spoke in detail about the development of the programme of experimental research at JINR and the status of the flagship megascience project NICA.

On 11 December, a delegation from the Joint Institute for Nuclear Research visited the University of the Western Cape (UWC), the Cape Peninsula University of Technology (CPUT) and the University of Cape Town (UCT), and held meetings with heads of research faculties and relevant departments to discuss cooperation issues.

The visit to the RSA universities was one of the events dedicated to the opening of a JINR Information Centre at the iThemba Cyclotron Laboratory (NRF: iThemba LABS) in South Africa.

At the University of the Western Cape, the delegation was welcomed by Dean of the Faculty of Natural Sciences D. Holgate, Head of the Department of Physics and Astronomy S. Halindintwali, and Head of the Department of Chemistry N. Jahed. At the Cape

Cape Town (RSA), December. The 23rd Meeting of the JINR–RSA Joint Coordination Committee held at the NRF: iThemba LABS, the accelerator centre of South Africa.
Photo: © iThemba LABS

Peninsula University of Technology, the delegation met with University's International Relations Manager T. Singh and heads of a number of relevant departments. Dean of the Faculty of Science H. Suleman, Head of the Department of Physics S. Peterson, Professor I. Barashenkov, and representatives of several projects spoke to the delegation at the University of Cape Town. The delegation members were acquainted with the infrastructure and scientific and educational programmes of the universities.

On 16–18 December, a visiting session of the Scientific Council of the Department of Physical Sciences of RAS was held in mixed format at JINR. It was devoted to the problem "Radiation physics of solid state". The event was aimed at the exchange of experience and discussion of the latest achievements in radiation physics of solid state. FLNR staff members and representatives of over 10 Russian scientific centres took part in the session.

Head of the FLNR Centre of Applied Physics P. Apel opened the scientific programme of the session with a report about the use of accelerated heavy ions as an instrument to produce micro- and nanopore structures in polymers and about a new special cyclotron DC-140, currently under construction at the laboratory. The accelerating complex will have three separate channels for testing microelectronics, radiation materials science and irradiation of polymer films. The scientist noted that the energy of ions accelerated at this facility (2.1 and 4.8 MeV/nucleon) allows the solution of a wide range of fundamental and applied tasks.

An excursion to the Superheavy Element Factory and Applied Physics Centre at FLNR was organized as part of the review of the modern scientific infrastructure of FLNR.

On 20 December, the JINR Science and Technology Council held its final 2024 meeting at the International Conference Hall to discuss the results of the year's work and prospects for further development of the Institute.

The JINR Director, Academician G. Trubnikov, informed the STC members of the year's main results in the scientific and administrative spheres of the JINR activity. His presentation covered the most important achievements of the laboratories and analyzed the results of the work of the JINR offices and departments. In conclusion of his speech, G. Trubnikov outlined highlights in the life of the Institute: extension of the agreement on scientific cooperation with CERN; meeting of the BRICS Working Group on Research Infrastructures at JINR; signing of a new cooperation agreement between JINR and China; visit of the Minister of Science and Technology of Vietnam to JINR; signing of a new cooperation agreement with Brazil's National Nuclear Energy Commission; session of the JINR Committee of Plenipotentiaries in Belarus.

Cape Town (RSA), 9–11 December. Visit to RSA universities by the JINR delegation

Dubna, 20 December. Presentation of the album-book about I. Chuvilo at the JINR Museum of History of Science and Technology

The main event of 2024 for JINR was the visit of the President of the Russian Federation Vladimir Putin on 13 June 2024, during which the technological launch of the NICA collider was officially initiated.

The event ended with a ceremony of awarding employees of the Joint Institute for their contribution to the development of science and diligent work.

CONFERENCES and MEETINGS

Eleven conferences were the largest among the scientific conferences and workshops held at JINR in 2024.

On 25–28 February, ***the International School on Nuclear Methods and Applied Research in Environmental, Material and Life Sciences (NUMAR-2024)***, organized by JINR and the Agency for Nuclear Energy and Advanced Technologies (AENTA), was held in Varadero (the Republic of Cuba). As part of the school programme, young scientists from Latin American countries, together with their scientific supervisors, attended lectures by leading scientists of JINR and scientific organizations from Cuba and Mexico.

At the opening of the NUMAR-2024 school, Plenipotentiary of the Government of the Republic of Cuba to JINR Dr. G. Walwyn Salas welcomed students from Cuba, Mexico, Costa Rica, the Dominican Republic, and wished them success in their future scientific careers. AENTA President G. Lóopez Bejerano presented a report on the Cuban research, development, and technological innovation programme. She mentioned that next year, 2025, will mark the 50th anniversary of successful collaboration between JINR and Cuba. JINR Vice-Director L. Kostov reported on the research areas of the Institute and its flagship projects.

The NUMAR-2024 programme was followed by a lecture series dedicated to the following topics: life sciences (radiopharmaceuticals production, and nuclear medicine diagnostics and therapy; physics and technology of hadron therapy of tumors; modern radiation imaging detectors for PET and CT; radiation biology and its applications in space research and radiation therapy, etc.), environmental sciences (radioecological assessment of environment; analytical techniques in environmental studies and nanotechnology; new technologies of wastewater treatment), materials science (application of neutron scattering to soft matter research; structural biophysics; functional, complex, and nanocomposite materials).

Varadero (Cuba), 25–28 February. Participants of the International School on Nuclear Methods and Applied Research in Environmental, Material and Life Sciences

More than 30 students and researchers from the Dominican Republic, Costa Rica, Cuba, and Mexico took part in the school. Within the framework of the school, a round-table discussion was held with scientists from JINR and scientific organizations of Cuba and Mexico.

On 23–25 April, ***the 13th Collaboration Meeting of the MPD Experiment at the NICA Facility*** was hosted by VBLHEP. Opening the meeting, JINR Vice-Director V. Kekelidze noted the robust progress and expansion of the MPD collaboration, which currently includes scientific groups from 38 centres around the world.

The Chief Engineer of the complex, E. Syresin, made a report on the current situation and running preparations for the launch of the NICA accelerator complex. He spoke about the successful testing of key structural elements of the complex: cyclic superconducting accelerators — the Nuclotron and the Booster, the electronic cooling systems, the power supply systems, as well as the main elements of the injection complex. In the collider tunnel, stations of high-frequency systems HF-1 and HF-2 were installed and tested for operability. According to the speaker, the first technological launch of the main systems of the NICA accelerator complex is planned for December 2024, and the launch of the first ion beam should take place in the spring of 2025.

The Head of the MPD collaboration, V. Ryabov, presented the collaboration work schedule for 2024–2025. The Head of the MPD Scientific and Experimental Department, V. Golovatyuk, covered in his talk the progress of work on creation of structural elements of the multipurpose detector, presenting their functional features and characteristics.

During the meeting, over 30 collaboration participants presented their reports on areas of current research in the field of heavy ion physics. As part of the meeting agenda, the participants took a tour of the experimental hall of the MPD detector.

On 20–24 May, ***the 22nd International Seminar on High Energy Physics "Quarks-2024"*** was held at the Park Hotel Azimut in the village of Ivanisovo (Yaroslavl Region). It was organized by the RAS Institute for Nuclear Research in collaboration with the Joint Institute for Nuclear Research. This seminar is part of a series of conferences held every two years since 1980 in Georgia (until 1992) and Russia. In recent years, the seminar has been held in cities of Russia's Golden Ring. More than 150 scientists from leading scientific centres of the Russian Federation participated in the Quarks-2024.

The seminar was opened by the Director of INR RAS, Corresponding Member of RAS M. Libanov. "Over 44 years, the seminar has evolved from a small gathering into a serious conference. Its popularity is growing, and a significant contribution to this has been made by Valery Rubakov, the permanent chairman of the Organizing Committee and the inspirer of the seminar. I hope that the traditions he

The Veksler and Baldin Laboratory of High Energy Physics, 23−25 April. Participants of the 13th Collaboration Meeting of the MPD Experiment at the NICA Facility

instilled in this seminar will be preserved," noted the Director of INR RAS, wishing the participants fruitful work in discussing new scientific problems.

The seminar was opened with plenary reports: "Holography in heavy ion collision physics" by RAS Corresponding Member I. Arefieva (MI RAS), "Quantum corrections to Hawking radiation" by E. Akhmedov (MIPT and ITEP), and "Axion-like dark matter and boson stars" by D. Levkov (ITMP MSU and INR RAS). The topics of other reports were very diverse and were initially defined by V. Rubakov, whose work is now continued by his students: physics beyond the Standard Model (rare processes and decays, Higgs boson phenomenology); cosmology and astroparticle physics; gravity and its modifications; neutrino physics; quantum chromodynamics and strong interactions; aspects of mathematical physics; selected experimental results.

The seminar was productive and would not have been possible without the financial and organizational support from JINR. More detailed information about the seminar, photos, and presentation files can be found on the website https://indico.quarks.ru/event/2024.

On 1–5 July, the conference hall of BLTP hosted ***the 74th International Conference on Nuclear Physics "Nucleus-2024: Fundamental Problems and Applications"***. This is the largest annual conference in Russia covering all energy ranges and aspects of modern nuclear physics. Different scientific centres take turns hosting the event each year, with JINR consistently being one of the organizers. In 2024, the Programme Committee of the conference included representatives of JINR, MSU, and SPbSU.

Dubna brought together 375 scientists, students, and postgraduates from leading nuclear research centres and universities of Azerbaijan, Bulgaria, China, Egypt, India, Kazakhstan, Russia, Slovakia, South Africa, Uzbekistan, and Vietnam to discuss the status and development tendencies of nuclear physics.

Opening the meeting, JINR Vice-Director L. Kostov noted the long history of the conference, originally named as "All-Union Meeting on Nuclear Spectroscopy" and first held in 950, and wished the participants fruitful and constructive discussions.

The first part of the plenary session included key reports on the development of the FLNR accelerator complex, new experimental data on the research of isotopes of superheavy elements, and physics of exotic nuclei.

BLTP and FLNR hosted parallel sections of the conference devoted to theoretical and experimental studies of nuclear reactions, nuclear structure, collisions of heavy ions at medium and high energies, neutrino physics, astrophysics, and the development of new experimental facilities. A separate section at DLNP was devoted to applied research, including radiation therapy, the use of nuclear diagnostic methods, etc. The applied part included reports by physicists working in medical centres, for whom the remote participation was organized. The

Alushta (Crimea), 9–15 June. Participants of the 13th International Conference of Young Scientists and Specialists "Alushta-2024"

Lipnya island, 19–21 July. The 28th Summer Scientific School for Young Scientists and Specialists "Lipnya-2024"

application of nuclear physics methods in geology was considered.

As part of the conference, an extensive poster session was held, divided into two parts: 73 poster presentations were presented in the hall of BLTP.

Based on the conference proceedings, scientific articles will be published in several peer-reviewed journals: "Nuclear Physics", "Bulletin of the Russian Academy of Sciences: Physics", "Moscow University Bulletin", and "International Journal of Modern Physics E".

On 10–17 July, ***the 24th International Baikal Summer School on Physics of Elementary Particles and Astrophysics*** was held in the Bolshiye Koty Village (Irkutsk Region, Russia) near the Baikal Biological Station of Irkutsk State University. The organizers of the school were the Joint Institute for Nuclear Research and Irkutsk State University.

In 2024, undergraduate and graduate students from Bosnia and Herzegovina, China, Cuba, India, Kazakhstan, Moldova, the Netherlands, and Vietnam participated in the school. Young scientists from Dubna, Irkutsk, Moscow, Novosibirsk, Saint Petersburg, Tomsk, and Vladivostok represented Russia.

A rich programme was prepared for the participants: lectures on general relativity theory, the Standard Model, multichannel astronomy, neutrino physics, quantum chromodynamics, supernova physics and nuclear physics, and interesting practice on Geant4 simulation and methods of computerized learning. During evening lectures, the attendees could improve their knowledge on design culture and learn about DNA sequence.

On 4–6 September, ***the ARIADNA Collaboration Meeting on Applied Research on Accelerated Ion Beams at the NICA Complex*** was held at JINR. The

Dubna, 3 August. Participants of the 25th Dzhelepov Cousins Tennis Tournament

meeting brought together about 150 participants from 33 organizations from 15 countries, including Armenia, Belarus, Bulgaria, Cuba, Egypt, India, Japan, Kazakhstan, Mexico, Romania, Russia, South Africa, Turkey, Uzbekistan, and Vietnam. The Russian participants of the meeting included representatives of the leading academic organizations and scientific centres working in space research, materials science, biomedicine, and other key areas of the ARIADNA collaboration. Leading Russian universities were represented by scientific groups from MIPT, MSU, SPbSU, RUDN, NRNU MEPhI, and the North Ossetian State University.

The main topic of the meeting was the discussion of the scientific programme of the collaboration on the eve of the expected session of the NICA complex in 2025.

The meeting was opened by JINR Vice-Director, Head of the NICA project V. Kekelidze, who, in particular, noted that the NICA project is ready to start experiments, including in the field of applied research, involving the performance of research on derived beams in specially created zones for these works.

ARIADNA Collaboration Leader, Deputy Head for Research of the VBLHEP Department of Methodological Research and Innovation O. Belov presented a report on the current status of the collaboration, talking about the most important events in its activities and the immediate tasks. At the moment, the cooperating organizations include 162 participants from 21 scientific centres; documents on the official entry of several more organizations are being prepared. Five stations for applied research have been created at the NICA accelerator complex, which will be able to operate in different energy ranges from 3.2 MeV/nucleon to 4 GeV/nucleon.

During the meeting, the participants heard 30 reports on the key areas of the ARIADNA collaboration scientific programme — applied research in the field of life sciences and biomedical applications, radiation materials science, microelectronics testing, applied nuclear technologies and the tasks of the ADSR project.

On the final day of the meeting, the participants visited the NICA accelerator complex. They inspected the Synchrophasotron building, where a chip irradiation station is located at the outlet of the injection complex, visited the MPD hall and Building 205, which houses a long-term irradiation station located in the BM@N facility area, as well as a sample preparation site.

The meeting was concluded with a round table, at which the participants discussed organizational issues of the collaboration, the entry of new cooperating organizations from different countries, the preparation of the first publications on behalf of the collaboration, and summed up the results of the meeting. The members of the collaboration took with interest the initiative to publish works in the new JINR journal "Natural Science Review", information about which was announced by A. Nezvanov, a representative of the working group on the creation of the journal.

From 15 to 20 September, the Dubna Resort Hotel (Alushta, Crimea) hosted ***the 15th International Seminar "Problems of Charged Particle Accelerators. Accelerators for Applied Research"***, dedicated to the memory of Professor V. Sarantsev. The Joint Institute for Nuclear Research, the Budker Institute of Nuclear Physics of the Siberian Branch of the Russian Academy of Sciences, and the RAS Scientific

Verbilki, 26–30 August. International School of Accelerator Physics "Cyclotrons"

Dubna, 4–6 September. Participants of the ARIADNA Collaboration Meeting on Applied Research on Accelerated Ion Beams at the NICA Complex

Council on Charged Particle Accelerators organized the event.

The seminar was aimed at exchanging information and discussing issues of accelerator physics and technology, physics of charged particle beams, development of new projects for lepton and hadron colliders, modernization of existing facilities, use of accelerators for fundamental and applied tasks, as well as at attracting young scientists to work on accelerator technology problems.

At the opening of the anniversary seminar, A. Sorin, Deputy Director for Research at the Veksler and Baldin Laboratory of High Energy Physics at JINR, spoke about fundamental research at the NICA accelerator complex. G. Baranov (BINP SB RAS), a Researcher at the Department of Accelerator Systems at SKIF (Siberian Circular Photon Source), reported on the status of the SKIF. Deputy Head of the VBLHEP JINR Accelerator Department A. Sidorin presented a report "Concurrent beams: The future of colliders". F. Emanov, a BINP SB RAS Researcher, spoke about the features and prospects of the VEPP-5 Electron–Positron Injection Complex.

Selected reports of the seminar will be published in the journal "Particles and Nuclei, Letters" available in both Russian and English.

On 8–10 October, ***the 13th Collaboration Meeting of the BM@N (Baryonic Matter at Nuclotron) Experiment at the NICA accelerator complex*** was held at VBLHEP. The key issues for the meeting participants were reconstruction and identification of strange particles, and the analysis of the event topology in nuclei collisions of the xenon beam (Xe) with the target of cesium iodide obtained in the last physical run of the BM@N experiment. Special attention was paid to the status of the physical analysis of the data of argon–nuclei interactions recorded earlier. The participants also discussed items of planning of the next run, including its future physical programme and detector configuration.

Under the plenary meeting programme, the head of the collaboration, Chief of the Scientific and Experimental Department of Baryonic Matter at the Nuclotron M. Kapishin made a report about the results and status of the BM@N experiment. At present, 214 representatives from 13 scientific centres of Kazakhstan, Bulgaria, Uzbekistan, Russia, and China take part in the collaboration. The speaker noted progress in the implementation of current work and solution of the main tasks on the analysis of the experimental data. The next physical run at the xenon beam will be held in 2025. As part of preparation activities, an additional station of silicon FSD detectors will be installed on the bismuth beam and a new 2-coordinate (*X*/*Y*) neutron detector with high granularity effect will be launched to measure yields and collective fluxes of neutrons.

Deputy Head of the MPD Scientific Experimental Department S. Piyadin reported about the status and plans of activities at the BM@N setup. All work on designing and manufacturing of mechanical supports was concluded with an account of refurbishment of the outer track system inside the SP-41 magnet. Lower GEM-detectors were installed. In preparation of refurbishment of BM@N detectors, two big CSC (Cathode Strip Chambers) detectors, as well as the ScWall (Scintillation Wall) detector, were fixed in the experimental pavilion. Besides, mechan-

ical supports were installed for two new time-of-flight detectors ToF-400 and four CSC detectors.

On the first day of the meeting, the participants of the collaboration discussed results of the analysis of data obtained in previous runs. VBLHEP scientists A. Zinchenko, K. Alishina, V. Kolesnikov and V. Troshin made reports on the current status of the data analysis on Λ-hyperon production.

A meeting of the BM@N Institutional Board was held during the event. As a result, Chief Researcher of VBLHEP R. Lednický was elected the new leader of the collaboration. Deputy Director of SRINP MSU M. Merkin was reaffirmed as the Chairman of the collaboration Institutional Board.

On the second day of the meeting, the participants continued discussions of the latest results of the data analysis and considered issues of preparation and use of the experiment detectors. The session on the software of the experiment was held on 10 October. On the whole, the programme of the 13th meeting included over 30 reports on implementation of the BM@N project.

On 14–16 October, ***the 14th Collaboration Meeting of the MPD Experiment*** was held at VBLHEP in a mixed format. The participants discussed topical issues of implementation of the MPD (Multi-Purpose Detector) project, including the readiness of the NICA accelerator complex, and considered new ideas and initiatives on the detector application.

Over 170 scientists took part in the meeting. During 3 days more than 30 reports were made by the participants on the topical research in heavy ion physics.

Leader of the MPD collaboration, Chief Researcher of the VBLHEP Sector of Elementary Particle Identification V. Ryabov reported on the experiment status. He spoke about the status of current work in preparation of key components and functional systems of the MPD detector and gave results of simulated data analysis. At present, more than 500 representatives from 38 scientific centres of Armenia, Belarus, Georgia, Kazakhstan, Moldova, Mongolia, Russia, Slovakia, China, and Mexico take part in the collaboration.

Head of the MPD Scientific and Experimental department V. Golovatyuk spoke about the activities on development and integration of key structural elements of the multipurpose detector. He gave a road map on implementation of the project with clear deadlines and specifics of the upcoming tasks. The engineer infrastructure of MPD is in the condition of high readiness. It is planned to accomplish the main installation work and conduct testing of functional detector systems. The construction finish and launching of the MPD experimental setup are scheduled for 2025.

On the second day of the event, the participants discussed issues of computing and software for the experiment implementation, and a meeting of representatives of the MPD Institutional Board took place. On 16 October, the concluding session of the meeting was held devoted to physical research at the experimental setup.

On 16–18 October, JINR's International Conference Hall hosted ***the 6th International Conference "Current Problems in Radiation Biology. Modification***

The Veksler and Baldin Laboratory of High Energy Physics, 8–10 October. The 13th Collaboration Meeting of the MB@N Experiment

The Veksler and Baldin Laboratory of High Energy Physics, 14–16 October. Participants of the 14th Collaboration Meeting of the MPD Experiment

of Radiation-Induced Effects". Modification of the biological effects of ionizing radiation has become an urgent issue due to the constant expansion of the application areas of ionizing radiation, as well as due to the complex modern geopolitical situation and the increased threat of radiation pollution of the environment. The conference was organized by the Russian Academy of Sciences (the Scientific Council on Radiobiology at the RAS Department of Physiological Sciences and the RAS Radiobiological Society) and JINR (the Laboratory of Radiation Biology). The Organizing Committee was headed by RAS Corresponding Member E. Krasavin and RAS Academician I. Ushakov.

The conference was held in a mixed format. More than 100 scientists took part in it in person and about 40 online — from Armenia, Azerbaijan, Belarus, Cuba, Mongolia, Russia, and Vietnam. The participants of the sessions represented scientific centres and institutes of RAS; the Academies of Sciences of Armenia, Belarus, and Azerbaijan; JINR; Russia's Federal Medical and Biological Agency (FMBA); the National Research Center "Kurchatov Institute" ; Lomonosov Moscow State University; and a number of Russian universities, scientific centers, and laboratories of the Ministry of Health of the Russian Federation, the Ministry of Defense of the Russian Federation, and some other agencies. Five plenary and 52 oral reports were heard; 10 poster presentations made by young scientists were considered. A competition for the best reports was held among young scientists.

The conference was opened by Chairman of the RAS Scientific Council on Radiobiology, Scientific Leader of JINR's Laboratory of Radiation Biology, RAS Corresponding Member E. Krasavin. He emphasized that the main goal of the meeting of leading radiobiologists is a search for new approaches to the development of methods for modifying radiation-induced effects for practical use in various fields of radiation protection, medicine, and space radiobiology. Welcoming the participants, he recalled the contribution of the founders of this field of radiobiology to its development: L. Gray, H. Patt and E. Cronkite, L. Kh. Eidus, E. Romantsev, S. Bresler, and S. Yarmonenko.

The scientific programme of the conference included reports by leading scientists and specialists who examined current issues of the modifying influence of physical and chemical factors on radiation-induced effects in genetics, radiation medicine, and space radiobiology; their practical applications; and the fundamental principles of developing radiation protection agents.

The relevance of the subject of the section that focused on radiation protection and search for anti-radiation drugs is confirmed by the number of reports by scientists from different institutions. The overwhelming majority of the presentations contained results of not only fundamental value, but also practical character.

As a result of a discussion, the conference participants adopted a decision to continue fundamental research on the modifying influence of factors of different nature on radiation-induced biological effects, which was then sent to the RAS Department of Biological Sciences and Department of Physiological Sciences, as well as to the Ministry of Science and Higher Education of the Russian Federation, Ministry

Dubna, 16–18 October. The 6th International Conference “Current Problems in Radiation Biology. Modification of Radiation-Induced Effects”

Dubna, 18 October. Seminar dedicated to the 80th anniversary of the birth of Academician A. Sissakian

of Health of the Russian Federation, FMBA, Rosatom, and Roscosmos. The decision also determined the most promising fields for further research.

On 28 October – 1 November, ***the 28th International Conference of Young Scientists and Specialists (AYSS-2024)***, organized by AYSS JINR, was held at the Meshcheryakov Laboratory of Information Technologies of JINR, gathering more than 260 youth representatives under 35 from 17 countries. During five days, the event attendees listened to lectures of JINR leading scientists and discussed their scientific reports in thematic sections.

Traditionally, an AYSS conference offers a rich scientific programme on a wide range of areas to young scientists and students. This year the participants had an opportunity to learn about the Institute's activities during 11 plenary lectures by leading JINR scientists and present results of their work in poster reports and at nine thematic sections: mathematical modeling and computer physics; particle accelerators and nuclear reactors; experimental nuclear physics; condensed matter physics; information technologies; high energy physics; theoretical physics; applied research; life sciences.

In cooperation with the Programme Committee, the Organizing Committee of the conference carried

The Meshcheryakov Laboratory of Information Technologies, 28 October – 1 November. The 28th International Scientific Conference of Young Scientists and Specialists (AYSS-2024)

Dubna, 21–24 October. Rosatom Scientific School on New Materials and Advanced Power Systems

out major preparatory work, paying special attention to the assessment of the scientific value of the submitted abstracts. According to the event programme, 194 talks and more than 40 posters were presented. A new feature of this year was attraction of invited section speakers. Each of nine AYSS-2024 sections was opened by a young scientist who had a reputation as a promising specialist and who became an example for young generation of scientists.

The Organizing Committee of the conference prepared four entertainment events to add to the rich scientific part of the programme, where participants could relax after the work during the day and meet each other. The evening networking is a traditional practice for all AYSS conferences, and it helped the participants to find new contacts not only in the professional sphere but also in life.

The conference was a real success due to active participation of students and young scientists. Thanks to their interest in new knowledge, enthusiasm and diligence, it became a bright scientific event in the life of JINR.

CONFERENCES, SCHOOLS, AND MEETINGS HELD BY JINR IN 2024

The Joint Institute sent 1580 specialists to solve cooperation issues and participate in scientific meetings and conferences; 608 specialists from other countries but Russia visited JINR for joint work and consultations, as well as for participation in meetings, conferences, and schools held at JINR; 70 international scientific conferences and schools, 16 workshops, and 13 meetings were organized and held.

No.	Title	Place	Date	Number of participants
1.	Series of the AYSS Seminars at the JINR Scientists' Club	Dubna	January – December	55
2.	Meeting of the Working Group under the CP Chair for Financial Issues of JINR	Hanoi, Vietnam	15–17 January	25
3.	59th Meeting of the Programme Advisory Committee for Particle Physics	Dubna	22–23 January	70
4.	Workshop on Chemistry of Superheavy Elements	Dubna	24–26 January	20
5.	58th Meeting of the Programme Advisory Committee for Condensed Matter Physics	Dubna	25–26 January	75
6.	58th Meeting of the Programme Advisory Committee for Nuclear Physics	Dubna	29–30 January	70

No.	Title	Place	Date	Number of participants
7.	DIAS-TH Winter School “Many-Particle Systems: From Condensed Matter to Quarks and Stars”	Dubna	29 January – 3 February	40
8.	Student programme START-2024, winter session	Dubna	February–June	29
9.	International School “Nuclear Theory and Astrophysical Applications”	Dubna	11–17 February	45
10.	135th session of the JINR Scientific Council	Dubna	15–16 February	110
11.	International Conference “Problems of Modern Mathematical Physics” (PMMP’24)	Dubna	19–23 February	60
12.	7th Technical Hackaton “Dubna-2024”	Dubna	24–25 February	100
13.	International School on Nuclear Methods and Applied Research in Environmental, Material and Life Sciences (NUMAR-2024)	Varadero, Cuba	25–28 February	125
14.	JINR–Cuba Meeting on Applied Research and Human Resource Development	Havana, Cuba	29 February – 1 March	125
15.	JINR Training Course “JINR Expertise for Member States and Partner Countries”	Dubna	11–15 March	30
16.	Seminar dedicated to the 40th anniversary of the commissioning of the IBR-2 reactor	Dubna	15 March	100
17.	AANL–JINR Workshop	Dubna	20–22 March	16
18.	Meeting of the JINR Finance Committee	Dubna	21 March	90
19.	Session of the Committee of Plenipotentiaries of the Governments of the JINR Member States	Dubna	22–23 March	110
20.	JINR Foundation Day	Dubna	23 March	
21.	Scientific School for Physics Teachers of Irkutsk, Voronezh and Saratov Regions	Dubna	25–29 March	30
22.	Scientific session of the Nuclear Physics Section of the Physical Sciences Department of RAS “Physics of Fundamental Interactions”	Dubna	1–5 April	180
23.	Section of the International Conference “Mathematics in the Constellation of Sciences”, dedicated to the anniversary of Academician V. Sadovnichy	Dubna	2 April	50
24.	13th Open Robotics Tournament CyberDubna-2024	Dubna	13 April	80
25.	30th International Seminar on Interaction of Neutrons with Nuclei “Fundamental Interactions & Neutrons, Nuclear Structure, Ultracold Neutrons, Related Topics” (ISINN-30)	Sharm El Sheikh, Egypt	14–18 April	200
26.	JINR Spring School of Information Technologies	Dubna	15–16 April	60
27.	13th Collaboration Meeting of the MPD Experiment at the NICA Facility	Dubna	23–25 April	160
28.	AANL–JINR Workshop	Yerevan, Armenia	25–26 April	40
29.	FLNP JINR – CSNS IHEP (China) Workshop on the Neutron Scattering Technology and Multi-Disciplinary Research	Dubna	13–15 May	35
30.	12th Collaboration Meeting of the BM@N Experiment at the NICA Facility	Almaty, Kazakhstan	13–17 May	135
31.	10th meeting of Scientific Council of RAS Physical Sciences Department on Heavy Ion Physics	Nizhni Novgorod	13–18 May	80
32.	Internship for Young Scientists and Specialists from the CIS Countries	Dubna	19 May – 18 June	25
33.	7th Collaboration Meeting of the SPD Experiment at the NICA Accelerator Complex	Almaty, Kazakhstan	20–24 May	60
34.	22nd International Seminar on High Energy Physics “Quarks-2024”	Ivanisovo, Yaroslavl Region	20–24 May	150

No.	Title	Place	Date	Number of participants
35.	Workshop on Mathematical Problems of Quantum Information Technologies	Dubna	27–28 May	40
36.	Student programme START-2024, summer session	Dubna	June–November	62
37.	Physics Day 2024	Dubna	1 June	300
38.	Rosatom and IAEA Regional School on Research Reactor Operation and Utilization	Dubna	3–4 June	20
39.	Stage 1 of the International Student Practice in JINR Fields of Research for students from RSA	Dubna	3–21 June	20
40.	Baikal Collaboration Meeting	Dubna	4–7 June	55
41.	13th International Conference of Young Scientists and Specialists “Alushta-2024”	Alushta, Crimea	9–16 June	60
42.	59th Meeting of the Programme Advisory Committee for Nuclear Physics	Dubna	13–14 June	70
43.	1st JINR–HSE Workshop	Dubna	14 June	70
44.	60th Meeting of the Programme Advisory Committee for Particle Physics	Dubna	17–18 June	70
45.	59th Meeting of the Programme Advisory Committee for Condensed Matter Physics	Dubna	24–25 June	75
46.	Scientific School for Schoolchildren of the Tomsk Region	Dubna	24–26 June	13
47.	6th Meeting of BRICS Working Group on Research Infrastructures and Megascience Projects	Dubna	1–3 July	50
48.	2nd Coordination Workshop on Swift and Multicharged Heavy Ions in Radiation Materials Science	Irkutsk	1–5 July	21
49.	74th International Conference on Nuclear Physics “Nucleus-2024: Fundamental Problems and Applications”	Dubna	1–5 July	150
50.	Meeting of the Working Group under the CP Chair for Financial Issues of JINR	Saint Petersburg	4–5 July	25
51.	36th Summer International Computer School (ICS-2024)	Dubna	5–17 July	90
52.	21st Summer School and Physics Workshop “Element 105”	Dubna	5 July – 5 August	40
53.	13th Scientific School for Physics Teachers at JINR	Dubna	8–12 July	24
54.	24th International Baikal Summer School on Physics of Elementary Particles and Astrophysics	Bolshiye Koty, Irkutsk Region	10–17 July	100
55.	2nd International Conference “Modern Problems of Condensed Matter Theory”	Dubna	15–19 July	80
56.	28th Summer Scientific School for Young Scientists and Specialists “Lipnya-2024”	Dubna	19–21 July	80
57.	International School “Advanced Methods of Modern Theoretical Physics: Integrable and Stochastic Systems”	Dubna	21–26 July	55
58.	Seminar on the Chinese–Russian Cooperation within the NICA-MPD/ITS Project	Dubna	23–24 July	25
59.	International Workshop “Supersymmetries and Quantum Symmetries” (SQS’24)	Dubna	29 July – 3 August	80
60.	International Seminar “Experimental Methods in Particle Physics”, dedicated to the 90th anniversary of the birth of Professor I. Golutvin	Dubna	8 August	85
61.	International School of Accelerator Physics “Cyclotrons”	Verbilki	25–30 August	85
62.	Collaboration Meeting of the JINR SRC Experimental Programme	Cyprus	1–7 September	16
63.	ARIADNA Collaboration Meeting on Applied Research on Accelerated Ion Beams at the NICA Complex	Dubna	4–6 September	170
64.	19th International Conference on Symmetry Methods in Physics	Yerevan, Armenia	8–13 September	70

No.	Title	Place	Date	Number of participants
65.	Stage 2 of the International Student Practice in JINR Fields of Research	Dubna	9–27 September	25
66.	4th Science School for Students of the Children's University of the Egyptian Academy of Scientific Research and Technology	Dubna	10–14 September	17
67.	Workshop on Accelerator Technology (Vietnam Accelerator Complex)	Dubna	10–20 September	20
68.	136th session of the JINR Scientific Council	Dubna	12–13 September	110
69.	China–JINR Workshop on Software and Computing for Future HEP Experiments	Listvyanka, Irkutsk Region	15–19 September	30
70	15th International Seminar "Problems of Charged Particle Accelerators. Accelerators for Applied Research", dedicated to the memory of Professor V. Sarantsev	Alushta, Crimea	15–20 September	150
71.	Workshop on Superconducting Cavities and Fast Cycling Magnets within Russia–China collaboration on NICA and HIAF projects	Dubna	26 September	24
72.	4th International School and Workshop on Few-Body Systems	Khabarovsk	30 September – 4 October	70
73.	Scientific Student Practice "Control Processes in Scientific Projects, Participation of Students in Scientific Research"	Dubna	7–11 October	22
74.	JINR Autumn School of Information Technologies	Dubna	7–11 October	100
75.	Introduction for the Offices of Plenipotentiaries and Officials Responsible for Liaison with JINR	Dubna	7–11 October	20
76.	13th Collaboration Meeting of the BM@N Experiment at the NICA Facility	Dubna	8–10 October	135
77.	19th All-Russian Science Festival "NAUKA 0+"	Moscow	11–13 October	1000
78.	14th Collaboration Meeting of the MPD Experiment at the NICA Facility	Dubna	14–16 October	160
79.	6th Conference "Current Problems in Radiation Biology. Modification of Radiation-Induced Effects"	Dubna	16–18 October	150
80.	Seminar dedicated to the 80th anniversary of the birth of Academician A. Sissakian	Dubna	18 October	80
81.	Scientific School for Schoolchildren of the Moscow Region	Dubna	21–23 October	10
82.	11th International Conference "Mathematical Modeling and Computational Physics" (MMCP-2024)	Yerevan, Armenia	21–25 October	90
83.	28th International Scientific Conference of Young Scientists and Specialists (AYSS-2024)	Dubna	28 October – 1 November	200
84.	Scientific School for Physics Teachers from Rosatom's host cities	Dubna	28 October – 1 November	20
85.	8th Collaboration Meeting of the SPD Experiment	Dubna	5–8 November	85
86.	Stage 3 of the International Student Practice in JINR Fields of Research	Dubna	5–22 November	25
87.	Meeting of the JINR Finance Committee	Minsk, Belarus	14 November	90
88.	Session of the Committee of Plenipotentiaries of the Governments of the JINR Member States	Minsk, Belarus	15–16 November	110
89.	Scientific School for Schoolchildren from Dubna and Astana (Kazakhstan)	Dubna	18–22 November	12
90.	JINR Training Course "JINR Expertise for Member States and Partner Countries"	Dubna	18–22 November	33
91.	International Conference "50 Yeras of Cold Fusion"	Yerevan, Armenia	19–24 November	60
92.	Autumn School on Quark–Gluon Matter Physics	Dubna	22–26 November	45

No.	Title	Place	Date	Number of participants
93.	2nd Scientific School-Seminar “New Methods for Processing Data of a Physical Experiment”	Dolgoprudny	2–4 December	80
94.	1st Scientific School for Teachers from the Republic of Belarus	Dubna	2–6 December	16
95.	Baikal Collaboration Meeting	Dubna	3–6 December	55
96.	2nd International African Symposium on Exotic Nuclei (IASEN-2024)	Gordon’s Bay, RSA	9–13 December	120
97.	Conference “75 Years of the Laboratory of Nuclear Problems”	Dubna	14 December	500
98.	Session of the Scientific Council of the Physical Sciences Department of the Russian Academy of Sciences on Radiation Physics of Solid State	Dubna	16–18 December	35
99.	Seminar on Results of MLIT Activities in 2024	Dubna	27 December	150

CENTRAL SERVICES

PUBLISHING DEPARTMENT

In 2024, the Publishing Department issued 63 titles of publications and 38 titles of official documents. Since 2024, official documents have been published in an updated design.

Abstracts and proceedings of the XXX International Seminar on Interaction of Neutrons with Nuclei (ISINN-30) (Sharm El Sheikh, 14–18 April 2024) and proceedings of the International Conference "Current Problems in Radiation Biology. Modification of Radiation-Induced Effects" (Dubna, 16–18 October 2024) were issued. Books of abstracts of the LXXIV International Conference "Nucleus-2024" (Dubna, 1–5 July 2024) and the International Conference "Mathematical Modeling and Computational Physics" (MMCP 2024) (Yerevan, 21–25 October 2024) were published as electronic editions.

Among the books published in 2024, the following are worth noting: "Physics in the Circle of Friends and Colleagues" by V. I. Komarov, "Weak Interactions of Elementary Particles" by M. V. Chizhov, "Malov Leonard Aleksandrovich: On the 85th Anniversary of His Birth", "Garii Vladimirovich Efimov: On the 90th Anniversary of His Birth", "Department of Nuclear Spectroscopy and Radiochemistry. 1958–2005: Memoirs, Documents, Photographs" (author-compiler Ts. Vylov), the collective monograph by A. O. Alekseev, T. V. Alekseeva, A. N. Afanasyeva, et al. "Astrobiology" (edited by A. Yu. Rozanov, E. A. Saprykin), "The Baikal-GVD Project at JINR from 2013 to 2023" by V. A. Bednyakov.

The UC textbook in three volumes was published: "Introduction to Experimental Nuclear Physics and Nuclear Electronics" by I. Vankov, D. Kamanin, Yu. Panebrattsev.

JINR Annul Reports for 2023, as well as the JINR report for the past seven-year period "Joint Institute for Nuclear Research. 2017–2023: A Brief Review of Scientific Achievements and Development of Research Infrastructure", were published in Russian and English.

A collection of poems by D. I. Blokhintsev, an outstanding physicist and the first director of JINR, was published. Also, on the occasion of the 80th anniversary of the birth of Academician A. N. Sissakian, the second edition of the collection of his poetry "The Smile of Thought" was published.

Work has begun on a new scientific electronic journal, "Natural Science Review". The journal's logo and cover design have been developed, and seven papers included in the first issue of the journal have been laid out and edited.

In 2024, six issues of the journal "Physics of Elementary Particles and Atomic Nuclei" (brief name "Particles and Nuclei"), including 237 papers, were published. Issue 1 contains the materials of the International Workshop "The Physics of the Dimuons at the LHC" (Dubna, 23–24 June 2022). Issue 3 presents the materials of the X International Conference "Distributed Computing and Grid Technologies in Science and Education" (Dubna, 3–7 July 2023). Issue 4 includes the materials of the XXV International Baldin Seminar on High Energy Physics Problems "Relativistic Nuclear Physics and Quantum Chromodynamics" (Dubna, 18–23 September 2023). Issue 6 contains the materials of the XXXV International Workshop on High Energy Physics "From Quarks to Galaxies: Elucidating Dark Sides" (Protvino, 28 November – 1 December 2023). Six issues of the journal "Physics of Elementary Particles and Atomic Nuclei, Letters" (brief name "Particles and Nuclei, Letters"), which include 203 papers, were published. Issue 3 provides the proceedings of the XXVIII International Conference "Russian Particle Accelerators Conference" (RuPAC'23) (Novosibirsk, 11–15 September 2023). Issue 4 contains the materials of the XXVII International Scientific Conference of Young Scientists and Specialists (AYSS-2023) (Dubna, 30 October – 3 November 2023).

The information bulletin "JINR News" continued to be published in Russian and English.

In 2024, 50 issues of the JINR weekly newspaper "Dubna: Science, Cooperation, Progress" were published.

As part of the exchange of scientific publications, the following JINR publications were sent to organizations cooperating with the Institute all over the world: JINR preprints and communications, the information bulletin "JINR News", JINR Annual Reports, the journals "Particles and Nuclei" and "Particles and Nuclei, Letters".

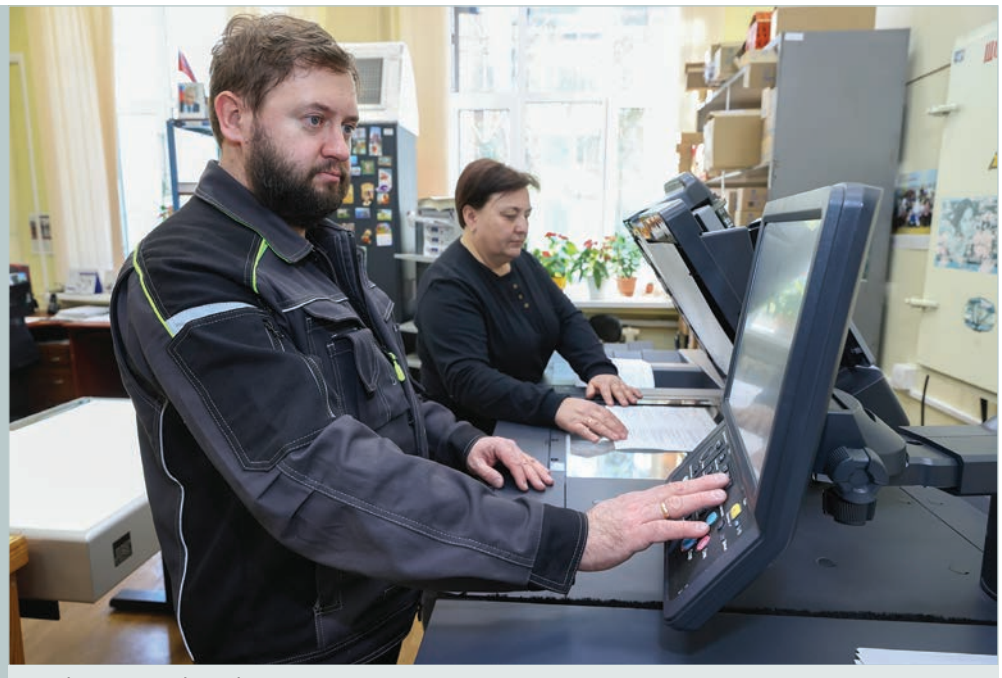
The Publishing Department forwarded 196 papers containing the results of research of Dubna scientists to the editorial boards of journals, to various conferences, symposia, meetings and schools held both in the JINR Member States and in other countries. Papers of the JINR staff members were submit-

Publications issued by the JINR Publishing Department in 2024

ted to the journals “Nuclear Physics”, “Bulletin of the Russian Academy of Sciences: Physics”, “Instruments and Experimental Techniques”, “Nuclear Physics and Engineering”, “Crystallography”, “Journal of Surface Investigation. X-Ray, Synchrotron and Neutron Techniques”, etc.

Work continued on placing periodicals and non-periodicals produced at JINR in the Russian Science Citation Index (RSCI) database on the platform of the Electronic Library System of the Scientific Electronic Library.

The process of making hardcover books



Working on a digital printing press

The Publishing Department fulfilled orders for printing photo posters and poster presentations of the Institute's staff members for submission to scientific forums. Information materials such as programmes, notebooks, badges, diplomas and certificates were printed for conferences and meetings.

At the request of the Laboratories and other JINR departments, bookbinding, photocopying and scanning of scientific-technical and engineering-design documentation were carried out. More than 120 thousand various forms were printed.

The staff of the Publishing Department continued to master the technology of hardcover book production. The equipment for this multi-operational process (a cover-making machine, a device for inserting a book block into a book cover, and a pressing and shading machine) was purchased in 2023. In 2024, three hardcover editions were published.

New equipment was installed — Konica Minolta Accurio Press 2100, a high-performance monochrome printing system. This machine is designed for black and white printing; it will replace the outdated and obsolete Czechoslovak offset printing machines.

SCIENCE and TECHNOLOGY LIBRARY

In 2024, the JINR Science and Technology Library (STL) rendered services to 1602 readers. An electronic loan system has been implemented. 3142 copies of publications were given out. As of 1 January 2025, the library stock amounted to 429 660 copies, 195 489 of them being in foreign languages.

Via the interlibrary loan system, 132 publications ordered by readers were received. Fifteen requests from other libraries were completed. On the whole, the library received 1033 copies of books, periodicals, preprints and theses from all acquisition sources, including 11 publications in foreign languages. All new publications were registered in the central catalogues, branch catalogues and in the information system "Absotheque".

One hundred issues of the express bulletins "Books", "Articles", "Preprints" were published, including 4156 titles. Electronic versions of the bulletins are available on the page "New Acquisitions" of the website of JINR Science and Technology Library and are distributed by e-mail. Subscription is available via the scientific library website in the section "Services" (http://ntb.jinr.ru/ntb_mail/newslist.html).

Literature exhibition dedicated to the 300th anniversary of the Russian Academy of Sciences

Weekly bibliographic lists of papers of JINR scientists with abstracts and URL references have been prepared for the Office of Chief Scientific Secretary.

The exhibitions of new acquisitions of books, preprints, periodicals and theses were arranged regularly. A total of 639 publications were displayed on them. Ten topical exhibitions were organized with 610 publications on display.

The electronic catalogues of books, journals, articles, preprints and theses are available on Internet at http://lib.jinr.ru:8080/OpacUnicode/.

In the electronic catalogue in the personal account, the readers can order requested literature and look through their reader's register forms.

The Bibliographic Index of Papers Published by JINR Staff Members in 2023 (1722 titles) was prepared by the Science and Technology Library and published by the JINR Publishing Department. The Index is available on the STL website, in section "Services" (http://ntb.jinr.ru/buk/2023/bibl_uk.php).

Three biobibliographic indexes have been prepared. The database of papers of JINR scientists is available online. A total of 2718 JINR preprints, monographs, conference proceedings, and annual reports have been scanned and added to the electronic catalogue.

The library received 58 titles of Russian periodicals.

Due to the national electronic subscription of the RCSI, JINR scientists have the electronic access to the full-text versions of journals of the following publishing houses: Springer, American Physical Society, American Mathematical Society, Wiley, as well as the journals "Nature", "Science", RAS journals, databases "Questel" and "EBSCO eBooks". The trial access to the resources of IEEE Electronic Library (IEL) has been arranged.

As part of the project "History of JINR and Dubna in Books, Journals and Central Newspapers", 119 new bibliographic records have been introduced. The information system "Literature about JINR Scien-

tists" (1083 records) has been put into service, which is available on the page of the site of JINR STL "Publications about JINR" (http://who-is-who.jinr.ru/catalog3/main.html/).

In 2024, within the information system "Absotheque", the input of documents to electronic catalogue was for: books — 350 titles, journals — 1090 numbers, preprints — 313 titles, theses and author's abstracts — 123 titles, book articles — 556 titles, and journal articles — 3785 titles.

As of 1 January 2025, the total number of records in the information system "Absotheque" was 356 648.

On requirements of the JINR Directorate, briefing notes and statistics of indicators of publication activity of JINR scientists and their co-authors from other countries and organizations with the usage of Web of Science, SCOPUS, and RSCI have been prepared.

PUBLICATION ACTIVITY OF JINR STAFF MEMBERS

According to the international SCOPUS database as of 22 January 2025, the bibliometric factors of the publication activity of JINR staff members in 2024 are as follows:

— total number of publications: 1401 (included are collaborative publications without JINR affiliation, but belonging to JINR);
— total number of citations: 1434;
— average citations per article: 1.02;
— h-index: 13.

Table 1. Joint publications with authors from JINR Member States

State*	Number of publications
Armenia	148
Azerbaijan	197
Belarus	132
Bulgaria	250
Cuba	46
Egypt	111
Georgia	207
Kazakhstan	87
Mongolia	208
Romania	320
Slovakia	194
Uzbekistan	87
Vietnam	31

*In alphabetical order.

Table 2. Joint publications with authors from JINR Associate Members

State*	Number of publications
Germany	466
Hungary	153
Italy	457
Serbia	211
South Africa	180

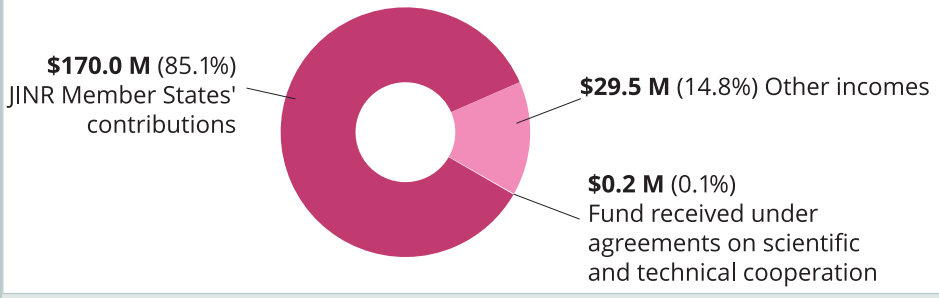
*In alphabetical order.

Table 3. Joint publications with authors from other states and regions

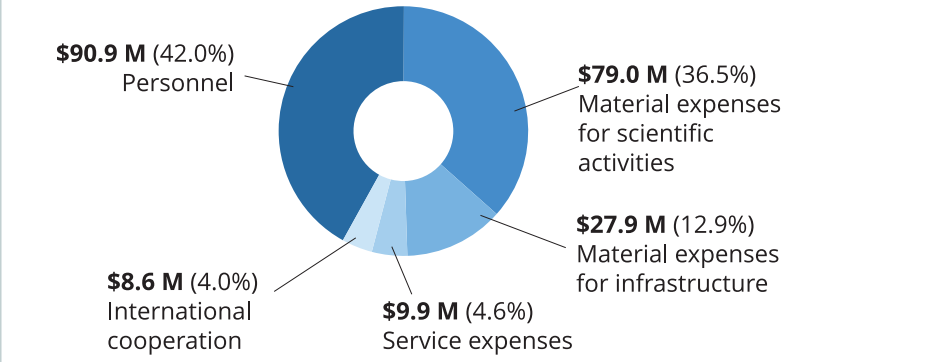
State/Region*	Number of publications	State/Region*	Number of publications
United States	456	Philippines	104
China	410	Belgium	103
Poland	408	Palestine	102
United Kingdom	407	Cyprus	99
Switzerland	381	Iran	79
Turkey	354	Lithuania	77
France	340	Estonia	76
Czech Republic	334	Ireland	76
Chile	315	Ecuador	75
Sweden	312	Kuwait	75
Netherlands	281	Latvia	75
South Korea	274	Malaysia	75
India	263	Sri Lanka	75
Brazil	259	Montenegro	74
Greece	251	Qatar	67
Austria	250	New Zealand	61
Spain	237	Puerto Rico	59
Japan	235	Peru	45
Thailand	231	Indonesia	44
Pakistan	226	Algeria	29
Portugal	209	Moldova	19
Taiwan	207	Saudi Arabia	16
Colombia	195	Bangladesh	5
Australia	192	Jordan	3
Norway	164	Dominican Republic	2
Denmark	162	Venezuela	2
Canada	141	Kyrgyzstan	1
Croatia	141	Lebanon	1
Mexico	134	Madagaskar	1
Finland	128	Malta	1
Israel	128	Nigeria	1
Ukraine	126	North Macedonia	1
Hong Kong	119	Oman	1
Slovenia	119	Paraguay	1
Morocco	118	Tajikistan	1
Argentina	115	Zambia	1
UAE	107		

*In decreasing order of the number of publications.

FINANCIAL ACTIVITIES



Execution of the JINR budget for 2024 in income — a total of **US$199.7 million**



Execution of the JINR budget for 2024 in expenses — a total of **US$216.3 million**

Contributions of JINR Member States for 2024 (in percent)

State	%	State	%
Republic of Armenia	0.13	Republic of Moldova	0.10
Republic of Azerbaijan	0.40	Mongolia	0.11
Republic of Belarus	0.72	Romania	2.13
Republic of Bulgaria	0.76	Russian Federation	87.15
Republic of Cuba	0.85	Republic of Uzbekistan	0.57
Arab Republic of Egypt	3.01	Socialist Republic of Vietnam	2.32
Georgia	0.16		
Republic of Kazakhstan	1.59		
Total:			100.0

In 2024, for the implementation of a number of scientific projects, the staff members of the Joint Institute for Nuclear Research received financial support of the Russian Scientific Foundation (RSF) and the Ministry of Science and Higher Education of the Russian Federation.

RSF rendered financial support to JINR scientific projects within the framework of the following competitions: "Conducting Fundamental Scientific Research and Exploratory Scientific Research in Separate Scientific Groups" (7 projects), "Conducting Fundamental Scientific Research and Exploratory Scientific Research in Small Separate Scientific Groups" (7 projects), "Conducting Fundamental Scientific Research and Exploratory Scientific Research by International Scientific Teams" — DFG (Germany), VAST (Vietnam) and BRFBR (Belarus) (1 project each), "Conducting Independent Research by Young Scientists" (3 projects), "Conducting Research by Scientific Groups under the Guidance of Young Scientists" (2 projects).

The Ministry of Science and Higher Education of the Russian Federation financed the project of the Frank Laboratory of Neutron Physics "Development and creation of elements of experimental stations based on pulsed and permanent neutron sources".

STAFF

Dubna, 5 April. At the ceremonial awarding of diplomas for scientific degrees

As of 1 January 2025, the total number of the staff members at the Joint Institute for Nuclear Research was 5047 (without temporary staff members).

Working at JINR are: RAS Academicians V. Matveev, I. Meshkov, Yu. Oganessian, G. Trubnikov, B. Sharkov, A. Rozanov (part-time); RAS Corresponding Members V. Aksenov, A. Belushkin, L. Grigorenko, D. Kazakov, V. Kekelidze, E. Krasavin, G. Shirkov; Full Member of the Mongolian Academy of Sciences O. Chuluunbaatar; 35 Professors, 25 Assistant Professors, 214 Doctors of Science, and 623 Candidates of Science.

In 2024, 510 people were employed and 533 people were discharged because of engagement period expiry and for other reasons.

AWARDS

In 2024, for their fruitful work at JINR and international cooperation, as well as in connection with the 300th anniversary of the founding of the Russian Academy of Sciences, JINR employees were awarded:

— state awards of the Russian Federation: the Order of Alexander Nevsky (1 staff member), the Order of Friendship (1 staff member), the Order of Honour (1 staff member), the Medal of the Order "For Merit to the Fatherland", I class (1 staff member), the Medal of the Order "For Merit to the Fatherland", II class (3 staff members), the Medal of Zhukov (1 staff member);

— awards of the President of the Russian Federation: the Gratitude of the President of the Russian Federation (1 staff member), the Honorary Letter of the President of the Russian Federation (1 staff member);

— awards of the Russian Academy of Sciences: the Jubilee Medal "300 Years of the Russian Academy of Sciences" (24 staff members), the V. I. Veksler Award (3 staff members);

— awards of the Ministry of Science and Higher Education of Russia: the Gratitude of the Ministry of Science and Higher Education of the Russian Federation (10 staff members), the title "Honorary Worker of Science and High Technologies of the Russian Federation" (8 staff members), the Honorary Diploma of the Ministry of Science and Higher Education of the Russian Federation (10 staff members);

— awards of the Rosatom State Corporation: the E. P. Slavsky Honorary Badge (1 staff member), the Academician A. P. Alexandrov Honorary Badge (1 staff member), the Academician I. V. Kurchatov Honorary Badge, II class (1 staff member), the Academician I. V. Kurchatov Honorary Badge, IV class (4 staff members), the Honorary Badge "For Contribution to the Development of the Nuclear Industry", I class (1 staff member), the Honorary Badge "For Contribution to the Development of the Nuclear Industry", II class (7 staff members), the Honorary Badge "Honorary Builder of the Nuclear Industry" (1 staff member), the Rosatom State Corporation Honorary Certificate (15 staff members), the Gratitude of the General Director of the Rosatom State Corporation (9 staff members);

— awards of the Moscow Region: the Honorary Letter of the Governor of the Moscow Region (1 staff member), the Honorary Diploma of the Moscow Regional Duma (3 staff members), the Honorary Letter of the Moscow Regional Duma (3 staff members), the Honorary Certificate of the Ministry of Investment, Industry, and Science of the Moscow Region (3 staff members), the Honorary Letter of the Minister of the Construction Complex of the Moscow Region (2 staff members);

— awards of the Dubna city: the Honorary Diploma of the Mayor of the Dubna city (47 staff members), the Gratitude of the Mayor of the Dubna city (20 staff members), the Honorary Diploma of the Council of Deputies of the Dubna city (36 staff members), the Gratitude of the Council of Deputies of the Dubna city (12 staff members);

— JINR awards: the JINR Honorary Diploma (5 staff members), the JINR Honorary Certificate (59 staff members), the JINR Honorary Letter (59 staff members), the title "Honorary JINR Staff Member" (11 staff members);

Two employees were awarded the Certificate of Honour of the State Committee for Science and Technology of the Republic of Belarus. One staff member received the badge "Honorary Donor of Russia" .

A total of 370 JINR employees were awarded.

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Joint Institute for Nuclear Research. 2024

Annual Report

2025-10

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Подписано в печать 13.05.2025.
Формат 60×84/8. Печать цифровая.
Усл. печ. л. 26,74. Уч.-изд. л. 36,36. Тираж 70 экз. Заказ № 61090.

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